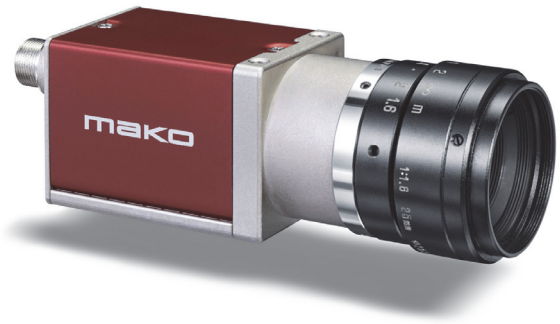
# Allied Vision Mako




# Technical Manual

## GigE Vision Cameras

V3.0.0

15 January 2015

Allied Vision Technologies GmbH
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Allied Vision

# Legal notice

### For customers in the U.S.A.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However there is no guarantee that interferences will not occur in a particular installation. If the equipment does cause harmful interference to radio or television reception, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the distance between the equipment and the receiver.
- Use a different line outlet for the receiver.
- Consult a radio or TV technician for help.

You are cautioned that any changes or modifications not expressly approved in this manual could void your authority to operate this equipment. The shielded interface cable recommended in this manual must be used with this equipment in order to comply with the limits for a computing device pursuant to Subpart B of Part 15 of FCC Rules.

### For customers in Canada

This apparatus complies with the Class B limits for radio noise emissions set out in the Radio Interference Regulations.

### Pour utilisateurs au Canada

Cet appareil est conforme aux normes classe B pour bruits radioélectriques, spécifiées dans le Règlement sur le brouillage radioélectrique.

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These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Allied Vision Technologies customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Allied Vision Technologies for any damages resulting from such improper use or sale.

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Allied Vision

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# Contacting Allied Vision

**Info**

- **Technical information:**
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# Introduction

This **Mako Technical Manual** describes in depth the technical specifications, dimensions, all pixel formats, bandwidth and frame rate related subjects.

For detailed information on camera features and controls refer to the **GigE Camera and Driver Features** and **GigE Camera and Driver Attributes** documents.

**www**

**Mako literature:**
http://www.alliedvisiontec.com/us/support/downloads/product-literature/mako.html

**Note**

We assume that you have already read the **GigE Installation Guide** and that you have installed the hardware and software on your PC or laptop (Gigabit Ethernet network card, cables). The **GigE Installation Guide** contains important safety warnings.

http://www.alliedvisiontec.com/emea/support/downloads/product-literature/hardware-installation-guide.html

## Document history

| Version | Date | Remarks |
|---|---|---|
| V2.0.0 | 2013-Aug-30 | New Manual - RELEASE Status |
| V2.0.1 | 2013-Sep-11 | • Added table of contents<br>• Added Camera cleaning instructions<br>• Updated the specifications for Mako G-223 and G-419<br>• Updated chapter Resolution and ROI frame rates on page 66 |
| V2.0.2 | 2013-Sep-16 | • Updated the frame rate information for Mako G-223 and Mako G-419 in Specifications and Resolution and ROI frame rates chapters<br>• Updated introduction to include link to Mako literature webpage<br>• Updated Status LEDs section<br>• Added captions to tables in Camera lenses section<br>• Added links to **AVT GigE Camera and Driver Features** document on page 53 and 57 |
| **to be continued on next page** | | |

Table 1: Document history

| Version | Date | Remarks |
|---|---|---|
| | | **continued from last page** |
| V2.0.3 | 2013-Nov-27 | • Updated gain control values for Mako G-223B/C (NIR) and Mako G-223B/C (NIR)<br>• Updated Table 23: Status LED (green) on page 44<br>• Updated the note on *StreamHoldCapacity* in Specifications and Frame memory sections<br>• Updated block diagrams in chapter Description of the data path on page 53<br>• Updated the Index |
| V2.0.4 | 2014-Feb-28 | • Updated available color pixel formats for Mako G-223B/C (NIR)and Mako G-223B/C (NIR)<br>• Updated optional accessories in the Specifications chapter<br>• Updated section Cross section: C-Mount on page 41<br>• Added section Heat dissipation on page 9<br>• Updated the operating temperature specification for Mako G-032B/C, Mako G-125B/C, Mako G-223B/C (NIR), and Mako G-223B/C (NIR)<br>• Updated block diagrams in chapter Description of the data path on page 53 to remove the RS232 mention<br>• Added Hirose cable information on page 45 |
| V2.1.0 | 2014-Oct-07 | • Updated and rearranged Specifications chapter<br>• Added Camera smart features on page 35<br>• Added trigger latency and jitter values for Mako G-032B/C and Mako G-125B/C<br>• Updated Mako standard housing drawing<br>• Updated table 28 on page 57<br>• Updated Camera features section<br>• Added Mako G-050 and Mako G-095 cameras:<br>– Added Mako G-050B/C and Mako G-095B/C specifications and spectral sensitivity plots<br>– Added camera lens information on page 37<br>– Added Mako G-050B/C: ROI frame rates and Mako G-095B/C: ROI frame rates sections<br>– Updated Description of the data path and Camera dimensions chapters |
| V3.0.0 | 2015-Jan-15 | • Updated Allied Vision logo<br>• Updated Camera cleaning instructions section<br>• Added Mako G-030, Mako G-131, and Mako G-192 cameras:<br>– Added Mako G-030B/C, Mako G-131B/C, and Mako G-192B/C specifications and spectral sensitivity plots<br>– Updated Table 12 : Mako camera smart features on page 35<br>– Added camera lens information on page 37 and 38<br>– Added Mako G-030B/C: ROI frame rates, Mako G-131B/C: ROI frame rates, and Mako G-192B/C: ROI frame rates sections<br>– Updated Description of the data path and Camera dimensions chapters |

Table 1: Document history

# Conventions used in this manual

To give this manual an easily understood layout and to emphasize important information, the following typographical styles and symbols are used:

## Styles

| Style | Function | Example |
|---|---|---|
| Bold | Programs, inputs or highlighting important things | **bold** |
| Courier | Code listings etc. | Input |
| Upper case | Register | REGISTER |
| Italics | Modes, fields | *Mode* |
| Parentheses and/or blue | Links | (Link) |

Table 2: Styles

## Symbols

**Note** This symbol highlights important information.

**Caution** This symbol highlights important instructions. You have to follow these instructions to avoid malfunctions.

**www** This symbol highlights URLs for further information. The URL itself is shown in blue.

Example: http://www.alliedvision.com

# More information

For more information on hardware and software read the following:

- The **GigE Installation Guide** describes the hardware installation procedures for Allied Vision GigE cameras and contains important safety instructions.
- **GigE Camera and Driver Features** describes the camera controls of Allied Vision's VIMBA SDK (GenICam) and feature related items.

**www**

To **download the GigE Installation Guide** and **GigE Camera and Driver Features**, go to:

http://www.alliedvisiontec.com/emea/support/downloads/product-literature.html

**www**

**Software packages** (including **documentation** and **release notes**) provided by Allied Vision can be downloaded from:

http://www.alliedvisiontec.com/emea/products/software.html

# Before operation

**Target group** This **Technical Manual** is the guide to detailed technical information of the camera and **is written for experts**.

**Getting started** For a quick guide on how to get started, read the **GigE Installation Guide** first.

**Caution**

Before operating any Allied Vision camera, read the **safety instructions** and **ESD warnings** in the **GigE Installation Guide**.

## Heat dissipation

Due to the small packaging and high speed of Mako cameras, take care to ensure that the housing temperature of the camera does not exceed 45 °C. The following are general guidelines for heat dissipation:

- Mount the camera on a heat sink such as a metal bracket.
- Lenses, when attached to a camera, act as a heat-sink and help reduce housing temperature.
- Ensure sufficient air flow. Use a fan if necessary.

**Note**

Housing temperature of the camera will increase during power-up and initial operation. This temperature will later stabilize.

# Camera cleaning instructions

This chapter describes safety instructions/cautions valid for **Mako** cameras in case of cleaning lenses, optical filters/protection glass or sensors.

**Note**

- Please read these instructions before you contact your Allied Vision camera dealer for assistance.
- Ask your Allied Vision camera dealer if you are not familiar with the procedures described below.

## Warranty

**www**

For details about camera warranty duration and sensor warranty terms, visit:

http://www.alliedvisiontec.com/emea/support/warranty.html

**Caution**

**Warranty precautions**

- To ensure your warranty remains in effect:
  - Do not open the camera housing.
  - Follow instructions described below.
  - Use only optical quality tissue/cloth if you must clean a lens or filter.
  - Use only optics cleaner (60% ethyl alcohol, 40% ether). Never use aggressive cleaners like benzine or spirit. Such cleaners may destroy the surface.
  - **Do not use compressed air which can push dust into camera and lens.**
- Allied Vision does not warranty against any physical damage to the sensor/filter/protection glass or lenses. **Use utmost care when cleaning optical components**.

## Avoiding the necessity of camera cleaning

When screwing/unscrewing the camera lens or dust cap, hold the camera with the C-Mount / CS-Mount opening towards the floor as shown in figure 1. This minimizes the possibility of any contaminants falling on the glass surface. Always store cameras and lenses with dust-caps installed.

Figure 1: Illustration of camera orientation when removing lens or dust cap

## Is it an impurity? – Identifying impurities

If you observe any image artefacts in your video preview of your Mako camera you may have impurities either on the lens, filter/protection glass, or on the sensor protection glass. Every Mako camera is cleaned prior to sealing and shipment; however, impurities may develop due to handling or unclean environments.

As shown in figure 2, impurities (dust, particles or fluids) on the sensor or optical components appear as a dark area, patch or spot on the image and remain fixed in the preview window while you rotate the camera over the target.

Do not confuse this with a pixel defect which appears as a distinct point. Particles can either rest loosely or can be more or less stuck to the optical surface.

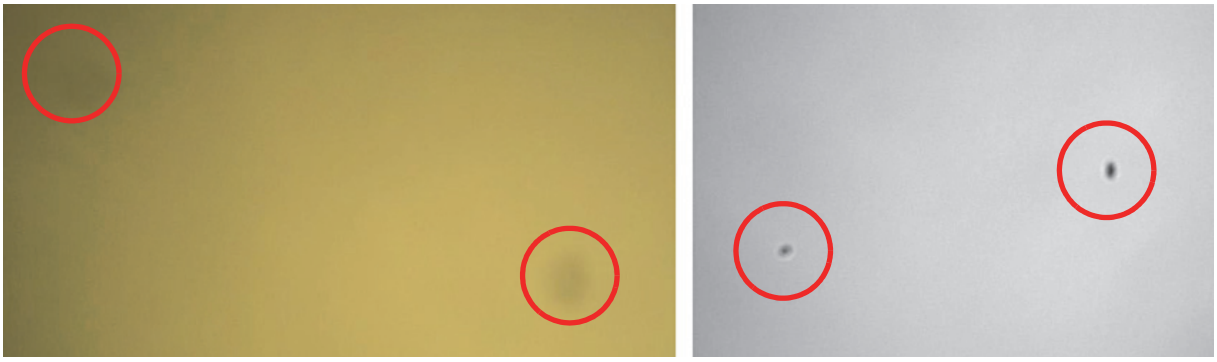


Figure 2: Image with tiny dust on the filter (left) and dust on the sensor (right)

## Where is the impurity? – Locating impurities

Before you dismount the lens you should find out if the impurity is on the filter, lens, or sensor. Therefore, you should capture a uniform image (e.g. a white sheet of paper) with the camera. The affected optical surface is identified when a suspected optical component is moved and the dirt follows this movement.

1. If you move only the lens (not the camera) and the impurity moves as well, the impurity is on the lens.
2. If you move the IR cut filter/protection glass window and the impurity moves as well:

Please carefully remove the filter/protection glass and clean it on both sides using the techniques explained below.

**Note**

- Taking out the filter requires special care.
- Ask your dealer to help you if you are not confident with the procedure.

Figure 3: Removing IR cut filter/protection glass using special tools (P/N: E9020001 for 16mm filter and P/N: 3851 for 22 mm filter)

3. If the impurity is neither on the lens nor the IR cut filter/protection glass, it is probably on the sensor.

## Cleaning Instructions

Perform all cleaning operations (lenses, filter/protection glass, and sensor) in a **dust-free clean-room**. The optical components are very fragile so it is important to avoid touching them with your fingers or any hard material.

1. Unplug the camera from any power supply before cleaning.
2. Apply a small amount of optics cleaner (60% ethyl alcohol, 40% ether) to a clean, new lens cleaning tissue.

   Acceptable material includes medical-grade sterile optical cotton, or lens tissue that is chemically pure and free from silicones and other additives.
   - **Do not** use cosmetic cotton.
   - **Do not** use consumer eyeglass cleaning cloths pre-treated with silicon.

   The cotton or lens tissue should be moist, but not dripping. Please hold the camera away from your body to avoid falling particles like flakes from skin on the sensor. Hold the camera sensor diagonally upwards.

Figure 4: Medical-grade sterile optical cotton

3. Wipe the glass surface with a spiral motion from the center to the rim. Normally, several spiral wipes are recommended. Wipe only on glass avoiding contact to metal surfaces, because microscopic dirt could be released and could cause scratches on the glass.
4. When you've finished cleaning, examine the surface in a strong light. Take an out-of-focus picture of a flat, illuminated surface to see if any dirt or dust remains.
5. If dust spots remain, repeat this procedure using new clean lens tissue (as described above).

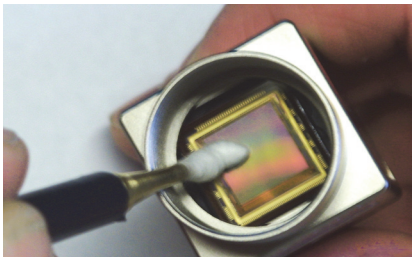


Figure 5: Sensor cleaning

**Figure 6: Don't use compressed air**

**Caution**

- Never wipe lenses with dry swabs or tissue—this causes scratches.
- Do not use any disposable cotton cosmetic swabs; they may contain contaminants.

6. If you want to clean your camera with compressed air despite of all the warnings:

**Caution**

- Use an air blower/compressed air only if you are familiar with cleaning a camera with this instrument.
- **Compressed air may push dust into cameras and lenses**. Therefore keep the pressure at a moderate strength only:
  - The pressure at the tube should be less than 1 bar (15 psi)
  - Operating distance: 5–30 cm

7. Gently blow the impurities off with dust-filtered, oil-free air (< 1 bar). Using ionized air helps to remove any dirt stuck to the optical component because of static electricity.

**Note**

If dust spots remain after cleaning twice, please contact your Allied Vision dealer.

# About Mako GigE cameras

**Mako** Mako cameras have a Gigabit Ethernet interface.

**GigE** GigE is the abbreviation for **Gig**abit **E**thernet.

All Mako cameras are GigE Vision V1.2 compliant cameras with Gigabit Ethernet interface. Mako cameras work with Gigabit Ethernet hardware and cable lengths up to 100 m.

**GigE Vision** The GigE Vision standard is an interface standard for digital machine vision cameras widely supported in the industrial imaging industry. In contrast, GigE (Gigabit Ethernet) is the network GigE Vision is built upon.

**GenICam** GenICam is the command structure for the GigE Vision camera controls. GenICam is administered by the European Machine Vision Association (EMVA). GenICam establishes a common camera control interface allowing third-party software to communicate with cameras from various manufacturers without customization. Allied Vision GigE cameras are GenICam V1.0 compliant.

# Conformity

Allied Vision Technologies declares under its sole responsibility that all standard cameras of the Allied Vision Mako family to which this declaration relates are in conformity with the following standard(s) or other normative document(s):

- CE, following the provisions of 2004/108/EG directive
- FCC Part 15 Class B
- RoHS (2011/65/EU)
- CE
- WEEE

We declare, under our sole responsibility, that the previously described Allied Vision Mako cameras conform to the directives of the CE.

## FCC – Class B Device

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential environment. This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense. You are cautioned that any changes or modifications not expressly approved in this manual could void your authority to operate this equipment.

# Specifications

**Caution**

Before operating any Allied Vision camera, read the **safety instructions** and **ESD warnings** in the **GigE Installation Guide.**

http://www.alliedvisiontec.com/emea/support/downloads/product-literature/hardware-installation-guide.html

**Caution**

Due to the small packaging and high speed of Mako cameras, take care to ensure that the **housing temperature of the camera does not exceed 45 °C**. The following are general guidelines for heat dissipation:

- Mount the camera on a heat sink such as a metal bracket.
- Lenses, when attached to a camera, act as a heat-sink and help reduce housing temperature.
- Ensure sufficient air flow. Use a fan if necessary.

**Note**

All measurements were done without protection glass / without filter.

The uncertainty in measurement of the quantum efficiency values is ±10%.

This is due to:

- Manufacturing tolerance of the sensor.
- Uncertainties in the measuring apparatus itself (Ulbricht sphere, optometer, etc.).

## Mako G-030B/C

| Feature | Specification |
|---|---|
| Resolution | 644 x 484 |
| Sensor | CMV300-3E7M1WP (mono) / CMV300-3E7C1WP (color) |
| Type | CMOS Progressive |
| Sensor size | Type 1/3 |
| Cell size | 7.4 µm |
| Lens mount | C / CS-Mount |
| Max frame rate at full resolution | 309 fps |
| Max image bit depth | 12 bit |

Table 3: Mako G-030B/C camera specifications

| Feature | Specification |
|---|---|
| On-board FIFO | 64 MByte, up to 99 frames at full resolution, Mono8/Bayer8, and a *GevSCPSPacketSize* = 8192 bytes per packet |
| Mono formats | Mono8, Mono12Packed, Mono12 |
| Color formats | BayerRG8, BayerRG12Packed, BayerRG12, Mono8, RGB8Packed, BGR8Packed, YUV411Packed, YUV422Packed, YUV444Packed |
| Exposure control | 83 µs to 2.0 s; 1 µs increments |
| Gain control | 0–26 dB |
| Binning | N/A |
| Decimation | Horizontal and Vertical: 1, 2, 4 factor |
| Opto-coupled I/Os | 1 input, 3 outputs |
| Voltage requirements | 12–24 VDC or PoE |
| Power consumption | 2.1 W @ 12 VDC, 2.3 W PoE |
| Trigger latency* | Idle state: 3.1 µs<br>Frame valid state: 3.1 µs |
| Trigger jitter* | Idle state: 1.2 µs<br>Frame valid state: 3.1 µs |
| Operating temperature | +5 °C to +45 °C (housing temperature) |
| Storage temperature | -10 °C to +70 °C ambient temperature (without condensation) |
| Body dimensions (L x W x H) | 60.5 x 29 x 29 mm; including connectors, without tripod and lens |
| Mass | 80 g (without lens) |
| Hardware interface standard | PoE, IEEE 802.3af 1000BASE-T, 100BASE-TX |
| Software interface standard | GigE Vision Standard 1.2 |
| Camera control interface | GenICam V1.0 compliant |
| Regulatory | CE, FCC Class B, RoHS (2011/65/EU), WEEE |
| *These values are calculated directly from the microcontroller source. These values are only valid for pixel formats < 16 bit per pixel and applicable in both Idle and Frame valid state:<br>– Idle state: sensor is ready and camera is idle, waiting for the next trigger<br>– Frame valid state: sensor is reading out and camera is busy. If the next frame is requested by an external trigger in this state, higher latency may occur as compared to the Idle state | |

Table 3: Mako G-030B/C camera specifications

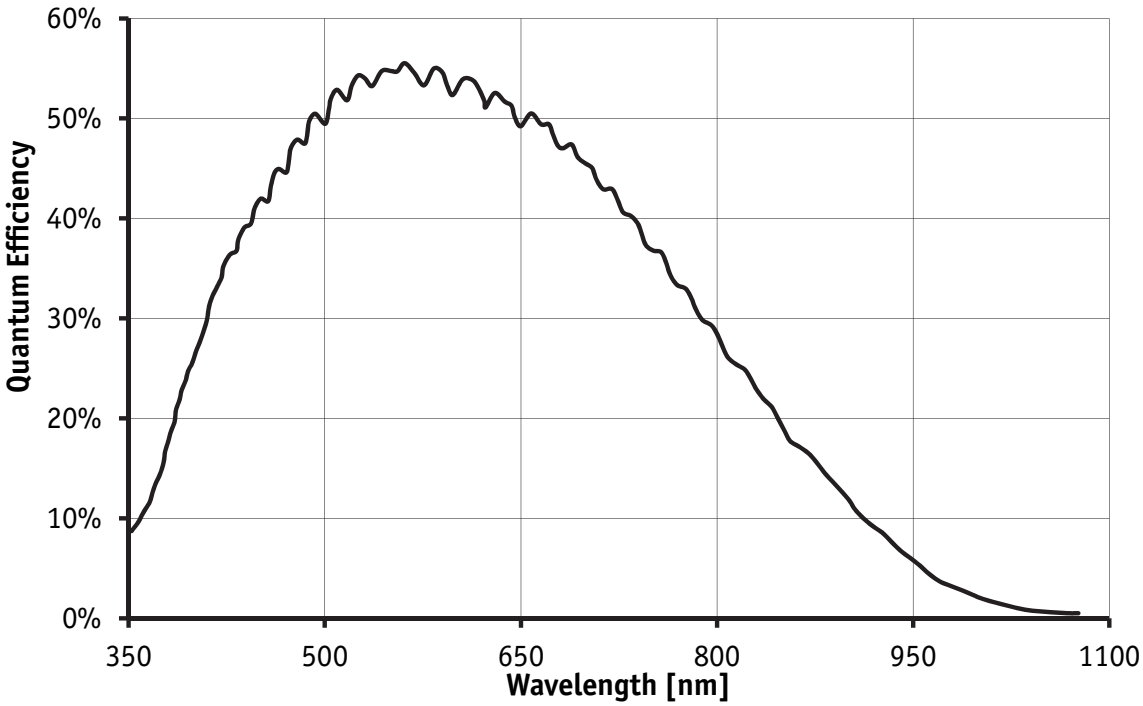



Figure 7: Spectral sensitivity of Mako G-030B

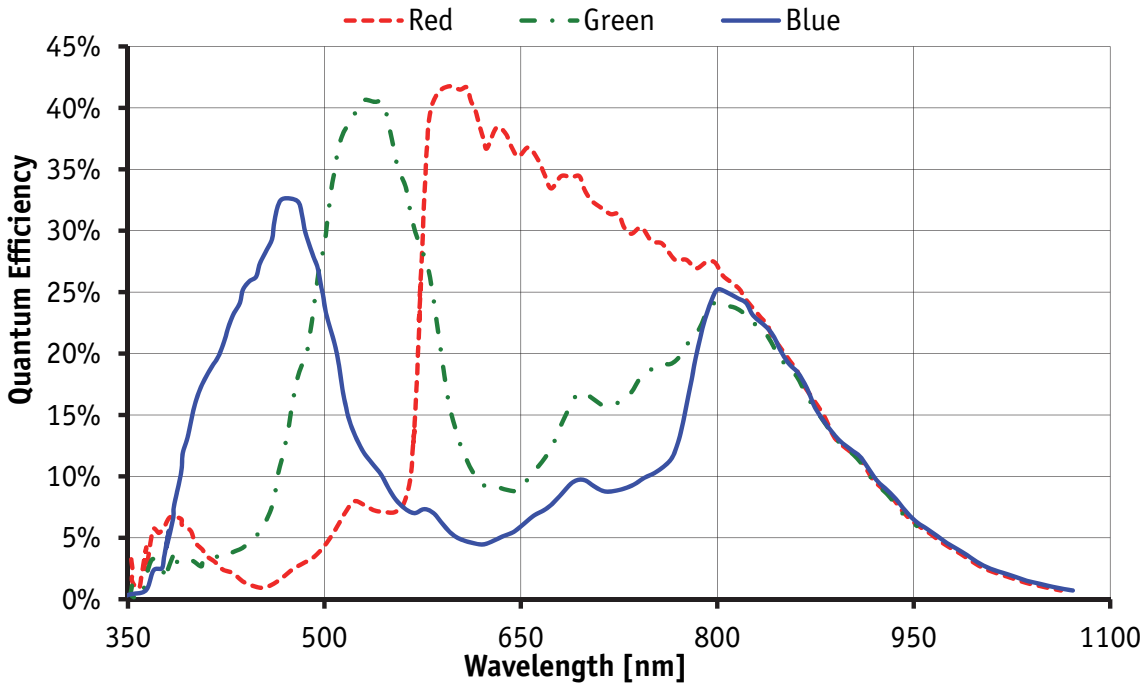



Figure 8: Spectral sensitivity of Mako G-030C

# Mako G-032B/C

| Feature | Specification |
|---|---|
| Resolution | 658 x 492 |
| Sensor | SONY IT CCD ICX424AL/AQ with HAD microlens |
| Type | CCD Progressive |
| Sensor size | Type 1/3 |
| Cell size | 7.4 µm |
| Lens mount | C / CS-Mount |
| Max frame rate at full resolution | 102 fps |
| Max image bit depth | 12 bit |
| On-board FIFO | 64 MByte, up to 202 frames at full resolution, Mono8/Bayer8, and a *GevSCPSPacketSize* = 8192 bytes per packet |
| Mono formats | Mono8, Mono12Packed, Mono12 |
| Color formats | BayerRG8, BayerRG12, BayerRG12Packed, Mono8, RGB8Packed, YUV411Packed, YUV422Packed, YUV444Packed, BGR8Packed |
| Exposure control | 10 µs to 93 s |
| Gain control | 0–30 dB |
| Horizontal binning | 1 to 8 columns |
| Vertical binning | 1 to 14 rows |
| Opto-coupled I/Os | 1 input, 3 outputs |
| Voltage requirements | 12–24 VDC or PoE |
| Power consumption | 2.4 W @ 12 VDC, 2.8 W PoE |
| Trigger latency* | Idle state: 7.2 µs<br>Frame valid state: 16.9µs |
| Trigger jitter* | Idle state: 4.0 µs<br>Frame valid state: 13.7 µs |
| Operating temperature | +5 °C to +45 °C (housing temperature) |
| Storage temperature | -10 °C to +70 °C ambient temperature (without condensation) |
| Body dimensions (L x W x H) | 60.5 x 29 x 29 mm; including connectors, without tripod and lens |
| Mass | 80 g (without lens) |
| Hardware interface standard | PoE, IEEE 802.3af 1000BASE-T, 100BASE-TX |
| Software interface standard | GigE Vision Standard 1.2 |
| Camera control interface | GenICam V1.0 compliant |
| Regulatory | CE, FCC Class B, RoHS (2011/65/EU), WEEE |
| *It is possible to start the exposure of the next frame while the previous frame is read out:<br>– Idle state: sensor is ready and camera is idle, waiting for the next trigger<br>– Frame valid state: sensor is reading out and camera is busy. If the Next frame is requested by an external trigger in this state, higher latency may occur as compared to the Idle state | |

Table 4: Mako G-032B/C camera specifications

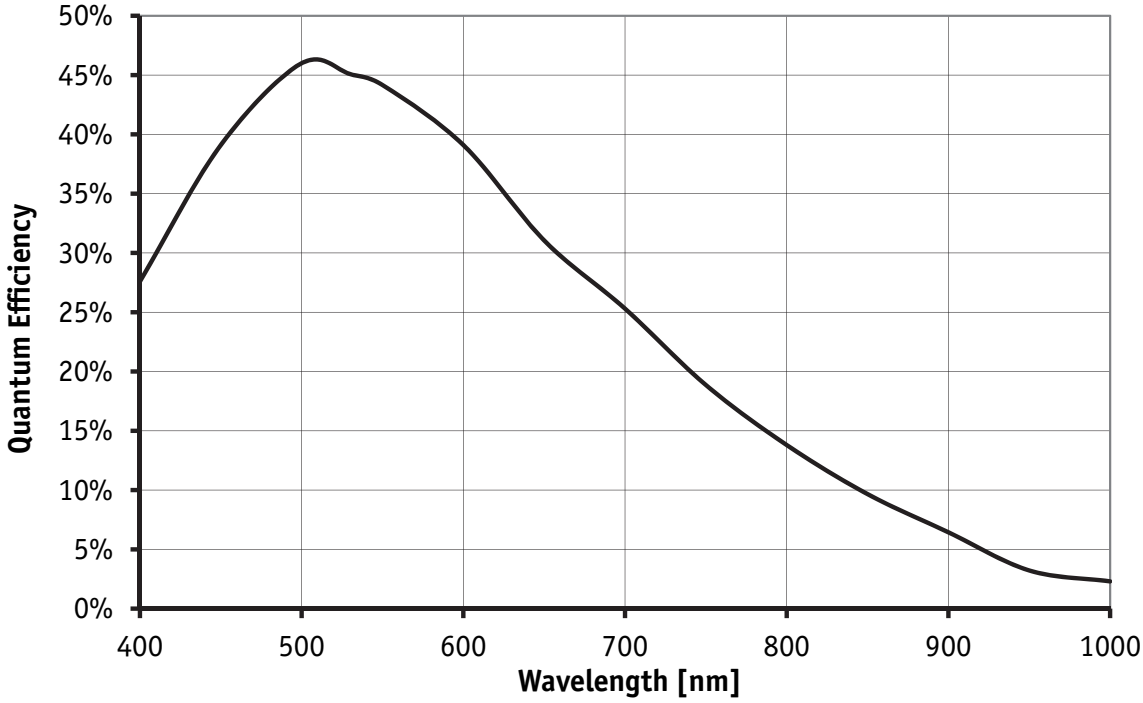



Figure 9: Spectral sensitivity of Mako G-032B (without protection/cover glass)

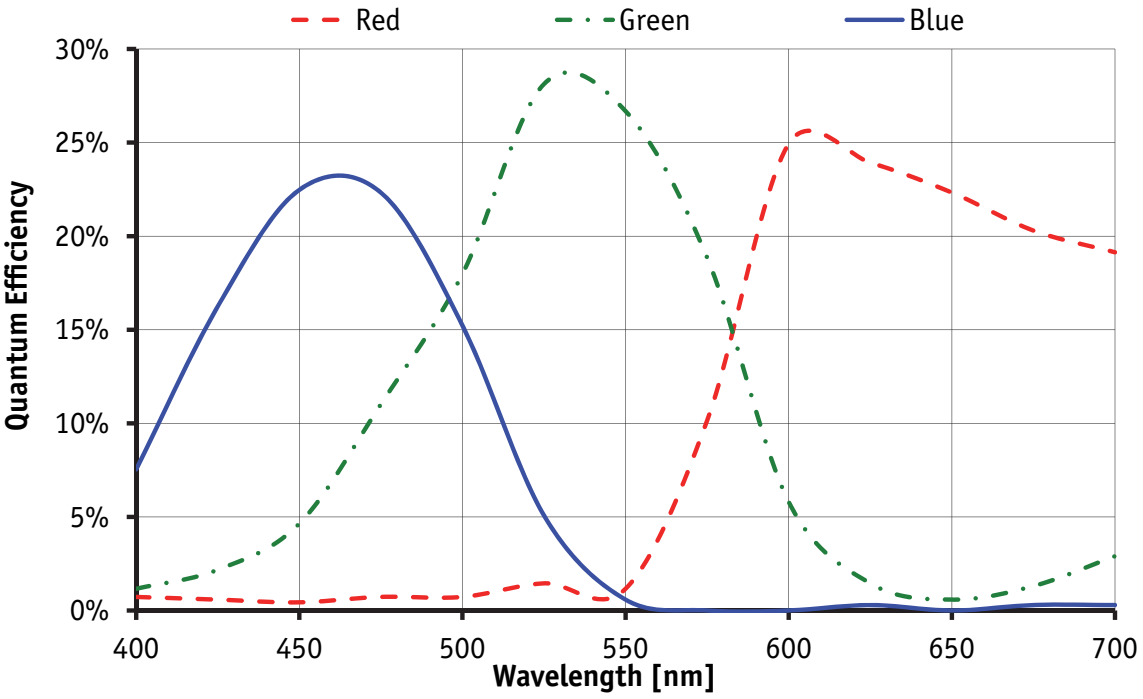



Figure 10: Spectral sensitivity of Mako G-032C (with IR cut filter)

# Mako G-050B/C

| Feature | Specification |
|---|---|
| Resolution | 812 x 614 |
| Sensor | SONY CCD ICX693ALA/AQA with Super HAD CCD II |
| Type | CCD Progressive |
| Sensor size | Type 1/3 |
| Cell size | 6.00 µm |
| Lens mount | C / CS-Mount |
| Max frame rate at full resolution | 71.2 fps |
| Max image bit depth | 12 bit |
| On-board FIFO | 64 MByte, up to 130 frames at full resolution, Mono8/Bayer8, and a *GevSCPSPacketSize* = 8192 bytes per packet |
| Mono formats | Mono8, Mono12Packed, Mono12 |
| Color formats | BayerRG8, BayerRG12, BayerRG12Packed, Mono8, RGB8Packed, YUV411Packed, YUV422Packed, YUV444Packed, BGR8Packed |
| Exposure control | 46 µs to 84 s |
| Gain control | 0–35 dB |
| Horizontal binning | 1 to 8 columns |
| Vertical binning | 1 to 14 rows |
| Opto-coupled I/Os | 1 input, 3 outputs |
| Voltage requirements | 12–24 VDC or PoE |
| Power consumption | 2.1 W @ 12 VDC, 2.4 W PoE |
| Trigger latency* | Idle state: 7.1 µs<br>Frame valid state: 18.3 µs |
| Trigger jitter* | Idle state: 4.0 µs<br>Frame valid state: 15.3 µs |
| Operating temperature | +5 °C to +45 °C (housing temperature) |
| Storage temperature | -10 °C to +70 °C ambient temperature (without condensation) |
| Body dimensions (L x W x H) | 60.5 x 29 x 29 mm; including connectors, without tripod and lens |
| Mass | 80 g (without lens) |
| Hardware interface standard | PoE, IEEE 802.3af 1000BASE-T, 100BASE-TX |
| Software interface standard | GigE Vision Standard 1.2 |
| Camera control interface | GenICam V1.0 compliant |
| Regulatory | CE, FCC Class B, RoHS (2011/65/EU), WEEE |
| *It is possible to start the exposure of the next frame while the previous frame is read out:<br>– Idle state: sensor is ready and camera is idle, waiting for the next trigger<br>– Frame valid state: sensor is reading out and camera is busy. If the Next frame is requested by an external trigger in this state, higher latency may occur as compared to the Idle state | |

Table 5: Mako G-050B/C camera specifications

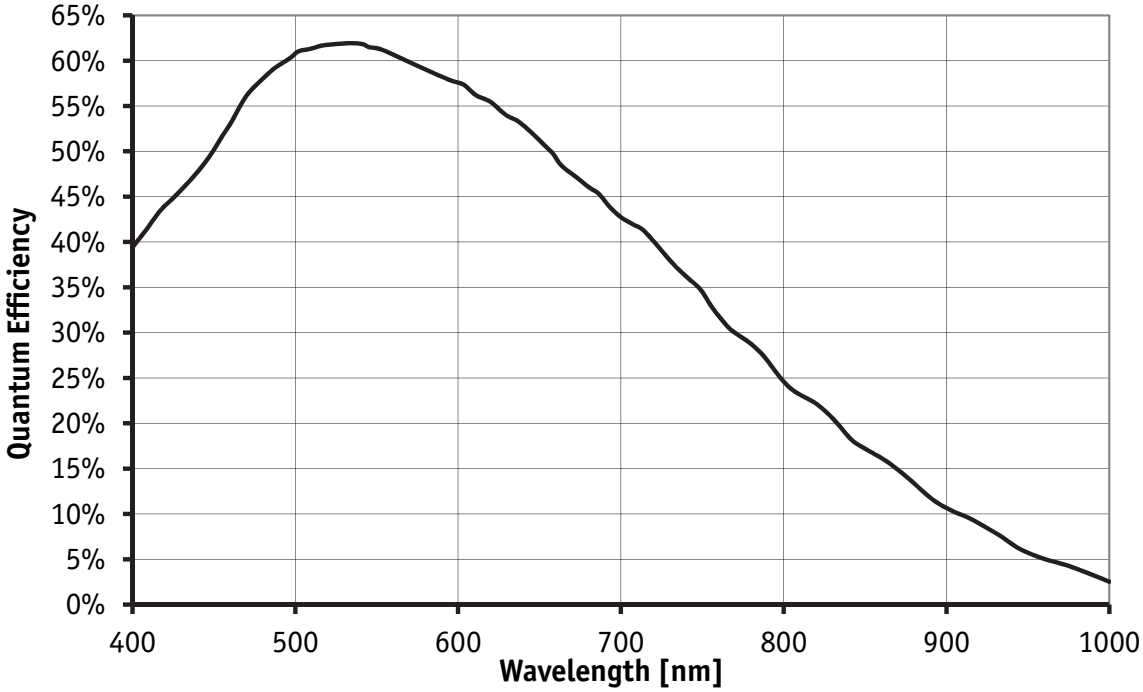



Figure 11: Spectral sensitivity of Mako G-050B (without protection/cover glass)

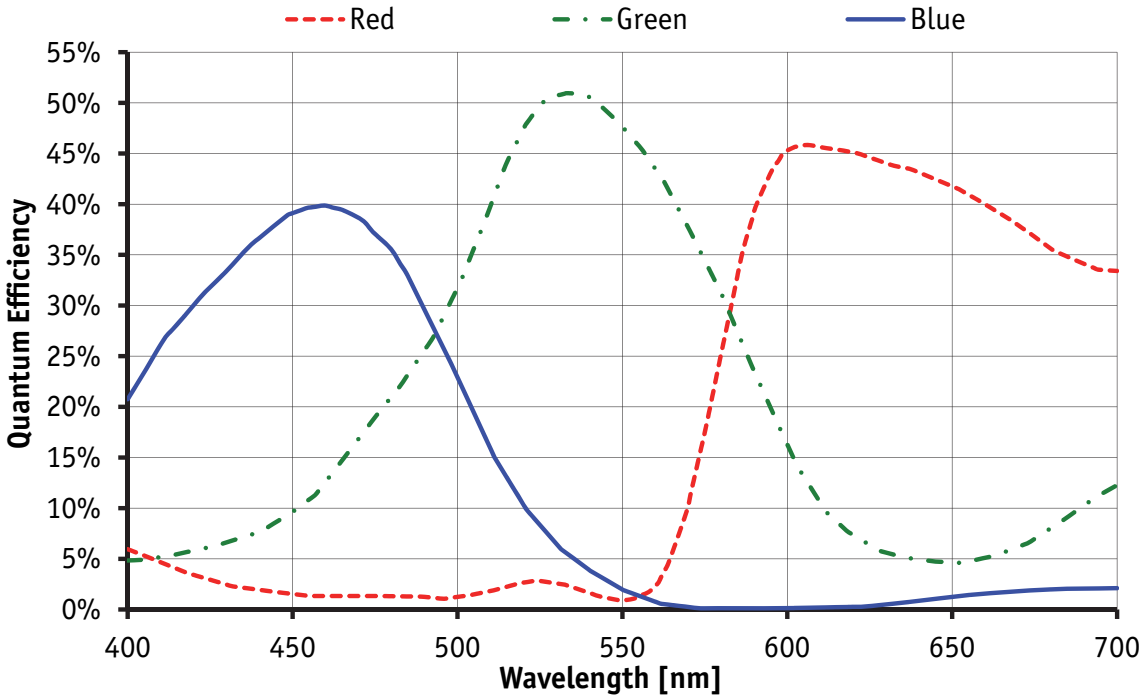



Figure 12: Spectral sensitivity of Mako G-050C (without IR cut filter)

# Mako G-095B/C

| Feature | Specification |
|---|---|
| Resolution | 1292 x 734 |
| Sensor | SONY IT CCD ICX692ALA/AQA with EXview HAD CCD II |
| Type | CCD Progressive |
| Sensor size | Type 1/3 |
| Cell size | 4.08 µm |
| Lens mount | C / CS-Mount |
| Max frame rate at full resolution | 42.8 fps |
| Max image bit depth | 12 bit |
| On-board FIFO | 64 MByte, up to 69 frames at full resolution, Mono8/Bayer8, and a *GevSCPSPacketSize* = 8192 bytes per packet |
| Mono formats | Mono8, Mono12Packed, Mono12 |
| Color formats | BayerRG8, BayerRG12, BayerRG12Packed, Mono8, RGB8Packed, YUV411Packed, YUV422Packed, YUV444Packed, BGR8Packed |
| Exposure control | 41 µs to 84 s |
| Gain control | 0–32 dB |
| Horizontal binning | 1 to 8 columns |
| Vertical binning | 1 to 14 rows |
| Opto-coupled I/Os | 1 input, 3 outputs |
| Voltage requirements | 12–24 VDC or PoE |
| Power consumption | 2.2 W @ 12 VDC, 2.5 W PoE |
| Trigger latency* | Idle state: 7.0 µs<br>Frame valid state: 22.8 µs |
| Trigger jitter* | Idle state: 4.0 µs<br>Frame valid state: 19.8 µs |
| Operating temperature | +5 °C to +45 °C (housing temperature) |
| Storage temperature | -10 °C to +70 °C ambient temperature (without condensation) |
| Body dimensions (L x W x H) | 60.5 x 29 x 29 mm; including connectors, without tripod and lens |
| Mass | 80 g (without lens) |
| Hardware interface standard | PoE, IEEE 802.3af 1000BASE-T, 100BASE-TX |
| Software interface standard | GigE Vision Standard 1.2 |
| Camera control interface | GenICam V1.0 compliant |
| Regulatory | CE, FCC Class B, RoHS (2011/65/EU), WEEE |
| *It is possible to start the exposure of the next frame while the previous frame is read out:<br>– Idle state: sensor is ready and camera is idle, waiting for the next trigger<br>– Frame valid state: sensor is reading out and camera is busy. If the Next frame is requested by an external trigger in this state, higher latency may occur as compared to the Idle state | |

Table 6: Mako G-095B/C camera specifications

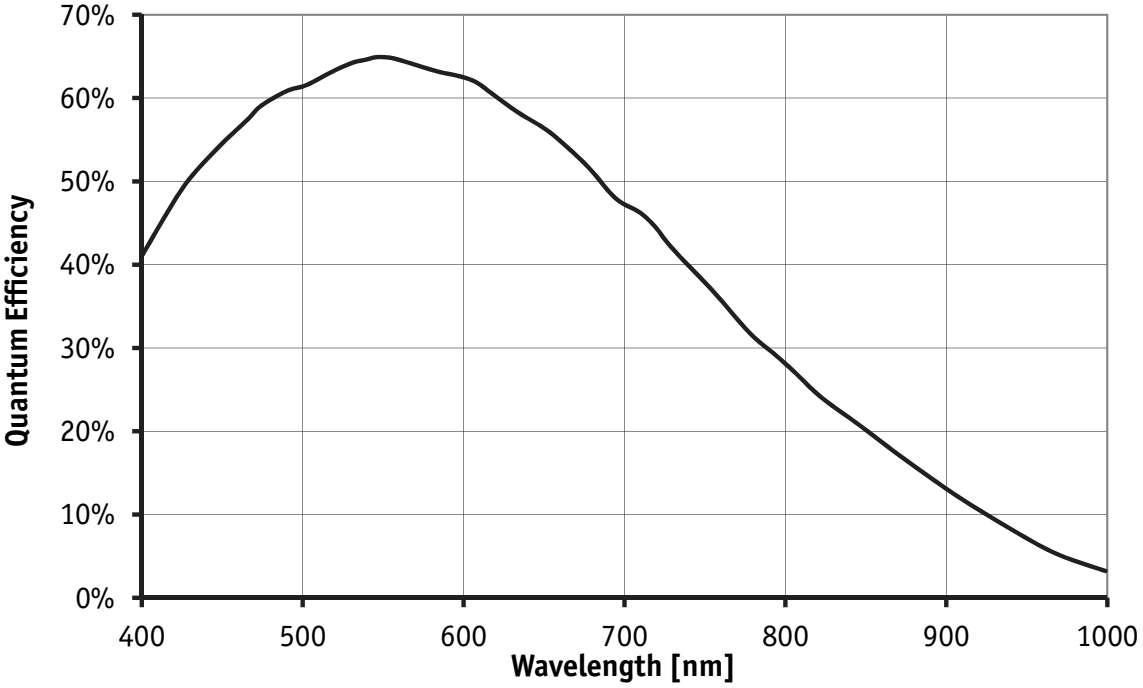



Figure 13: Spectral sensitivity of Mako G-095B (without protection/cover glass)

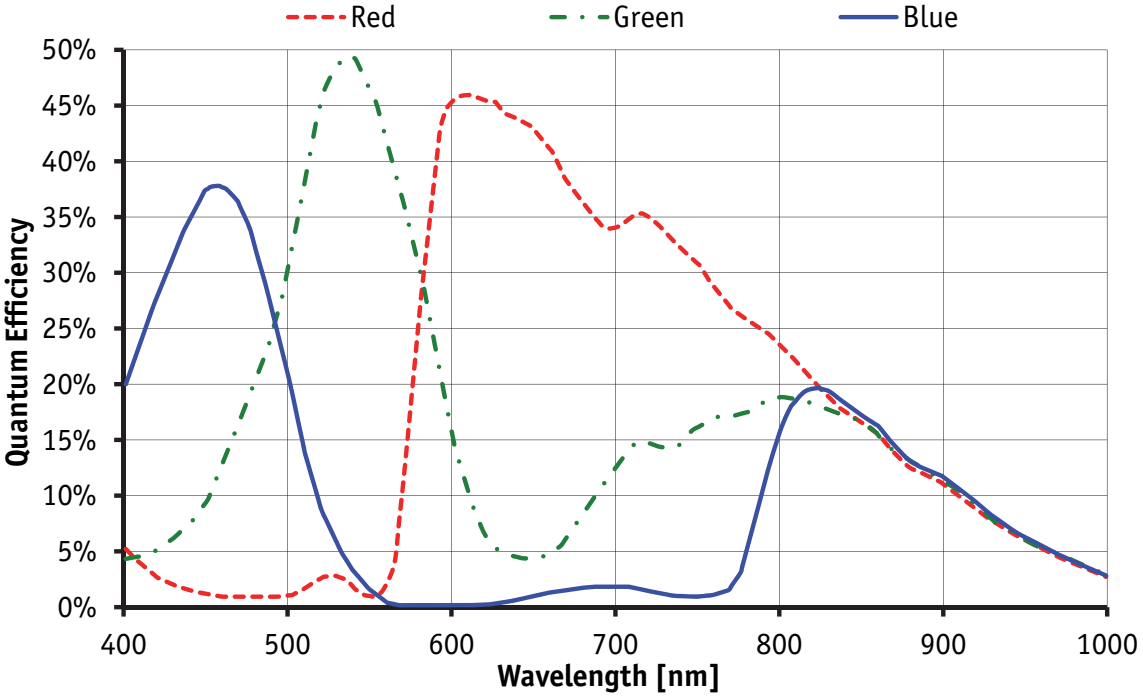



Figure 14: Spectral sensitivity of Mako G-095C (without IR cut filter)

# Mako G-125B/C

| Feature | Specification |
|---|---|
| Resolution | 1292 x 964 |
| Sensor | SONY IT CCD ICX445ALA/AQA with EXview HAD microlens |
| Type | CCD Progressive |
| Sensor size | Type 1/3 |
| Cell size | 3.75 µm |
| Lens mount | C / CS-Mount |
| Max frame rate at full resolution | 30 fps |
| Max image bit depth | 12 bit |
| On-board FIFO | 64 MByte, up to 52 frames at full resolution, Mono8/Bayer8, and a *GevSCPSPacketSize* = 8192 bytes per packet |
| Mono formats | Mono8, Mono12Packed, Mono12 |
| Color formats | BayerRG8, BayerRG12, BayerRG12Packed, Mono8, RGB8Packed, YUV411Packed, YUV422Packed, YUV444Packed, BGR8Packed |
| Exposure control | 12 µs to 84 s |
| Gain control | 0–30 dB |
| Horizontal binning | 1 to 8 columns |
| Vertical binning | 1 to 14 rows |
| Opto-coupled I/Os | 1 input, 3 outputs |
| Voltage requirements | 12–24 VDC or PoE |
| Power consumption | 2.3 W @ 12 VDC, 2.7 W PoE |
| Trigger latency* | Idle state: 8.0 µs<br>Frame valid state: 25.0 µs |
| Trigger jitter* | Idle state: 4.0 µs<br>Frame valid state: 21.0 µs |
| Operating temperature | +5 °C to +45 °C (housing temperature) |
| Storage temperature | -10 °C to +70 °C ambient temperature (without condensation) |
| Body dimensions (L x W x H) | 60.5 x 29 x 29 mm; including connectors, without tripod and lens |
| Mass | 80 g (without lens) |
| Hardware interface standard | PoE, IEEE 802.3af 1000BASE-T, 100BASE-TX |
| Software interface standard | GigE Vision Standard 1.2 |
| Camera control interface | GenICam V1.0 compliant |
| Regulatory | CE, FCC Class B, RoHS (2011/65/EU), WEEE |
| *It is possible to start the exposure of the next frame while the previous frame is read out:<br>– Idle state: sensor is ready and camera is idle, waiting for the next trigger<br>– Frame valid state: sensor is reading out and camera is busy. If the Next frame is requested by an external trigger in this state, higher latency may occur as compared to the Idle state | |

Table 7: Mako G-125B/C camera specifications

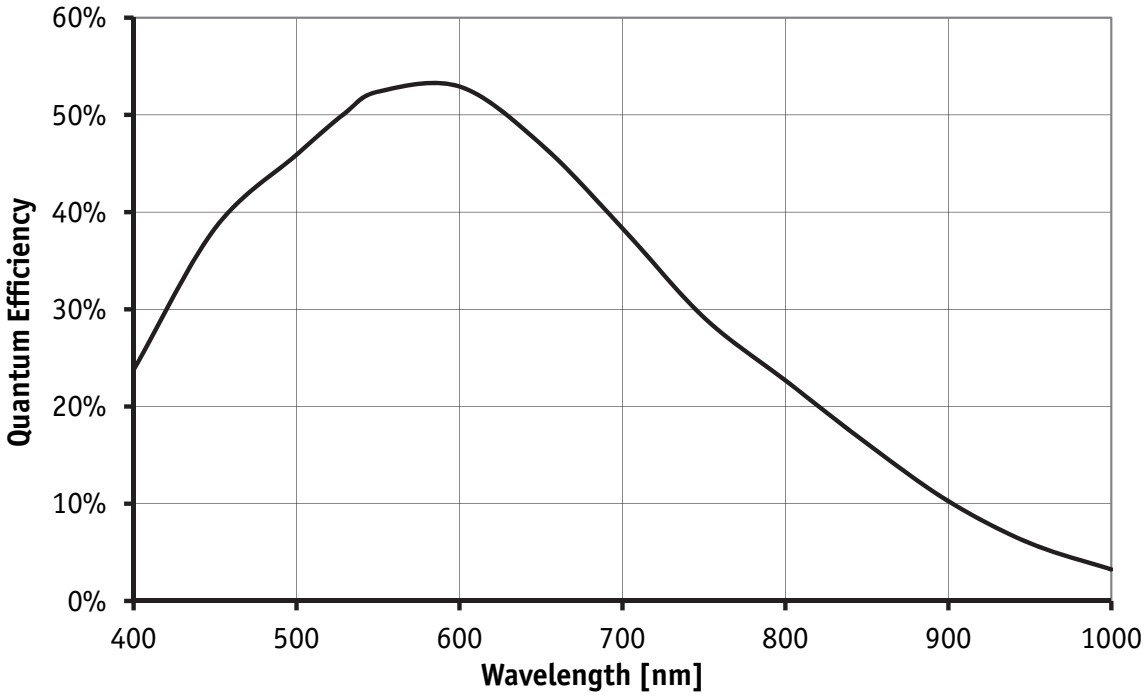



Figure 15: Spectral sensitivity of Mako G-125B (without protection/cover glass)

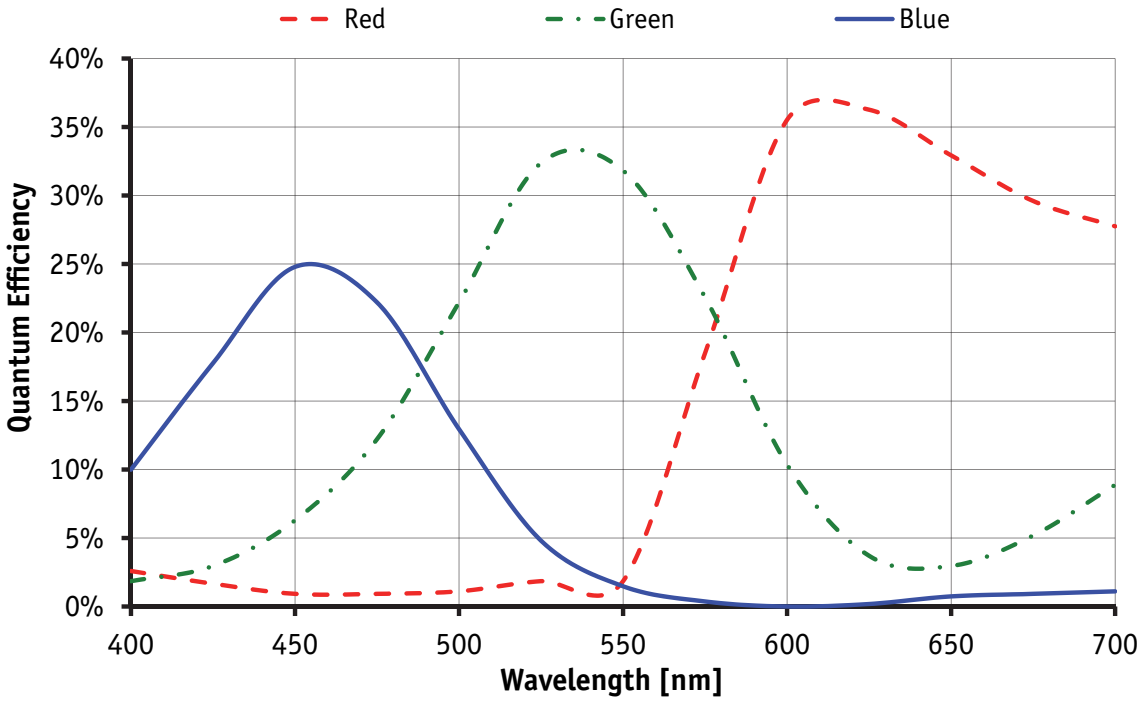



Figure 16: Spectral sensitivity of Mako G-125C (with IR cut filter)

# Mako G-131B/C

| Feature | Specification | | | |
|---|---|---|---|---|
| Resolution | 1280 x 1024 | | | |
| Sensor | e2v EV76C560 | | | |
| Type | CMOS Progressive | | | |
| Sensor size | Type 1/1.8 | | | |
| Cell size | 5.3 µm | | | |
| Lens mount | C / CS-Mount | | | |
| Max frame rate at full resolution | 62 fps | | | |
| Max image bit depth | 10 bit | | | |
| On-board FIFO | 64 MByte, up to 50 frames at full resolution, Mono8/Bayer8, and a *GevSCPSPacketSize* = 8192 bytes per packet | | | |
| Mono formats | Mono8, Mono10 | | | |
| Color formats | BayerGB8, BayerGB10, Mono8, RGB8Packed, BGR8Packed, YUV411Packed, YUV422Packed, YUV444Packed | | | |
| Exposure control | PixelFormat | ShutterMode: Global | ShutterMode: GlobaReset | ShutterMode: Rolling |
| | Mono8, Mono10, BayerGB8, BayerGB10, YUV411Packed, YUV422Packed | 12 µs to 1.012 s | 12 µs to 0.978 s | 12 µs to 0.994 s |
| | RGB8Packed, BGR8Packed, YUV444Packed | 12 µs to 2.124 s | 12 µs to 2.053 s | 12 µs to 2.086 s |
| Gain control | 0–24 dB | | | |
| Binning | Horizontal: 1 to 2 pixels; Vertical: 1 to 2 rows | | | |
| Decimation | Horizontal and Vertical: 1, 2, 4, 8 factor | | | |
| Opto-coupled I/Os | 1 input, 3 outputs | | | |
| Voltage requirements | 12–24 VDC or PoE | | | |
| Power consumption | 2.0 W @ 12 VDC, 2.2 W PoE | | | |
| Trigger latency* | Idle state: 32.6 µs<br>Frame valid state: 32.6 µs | | | |
| Trigger jitter* | Idle state: 8.1 µs<br>Frame valid state: 8.1 µs | | | |
| Operating temperature | +5 °C to +45 °C (housing temperature) | | | |
| Storage temperature | -10 °C to +70 °C ambient temperature (without condensation) | | | |
| Body dimensions (L x W x H) | 60.5 x 29 x 29 mm; including connectors, without tripod and lens | | | |
| Mass | 80 g (without lens) | | | |
| Hardware interface standard | PoE, IEEE 802.3af 1000BASE-T, 100BASE-TX | | | |
| Software interface standard | GigE Vision Standard 1.2 | | | |
| Camera control interface | GenICam V1.0 compliant | | | |
| Regulatory | CE, FCC Class B, RoHS (2011/65/EU), WEEE | | | |
| *These values are calculated directly from the microcontroller source. These values are only valid for pixel formats < 16 bit per pixel and applicable in both Idle and Frame valid state:<br>– Idle state: sensor is ready and camera is idle, waiting for the next trigger<br>– Frame valid state: sensor is reading out and camera is busy. If the next frame is requested by an external trigger in this state, higher latency may occur as compared to the Idle state | | | | |

Table 8: Mako G-131B/C camera specifications

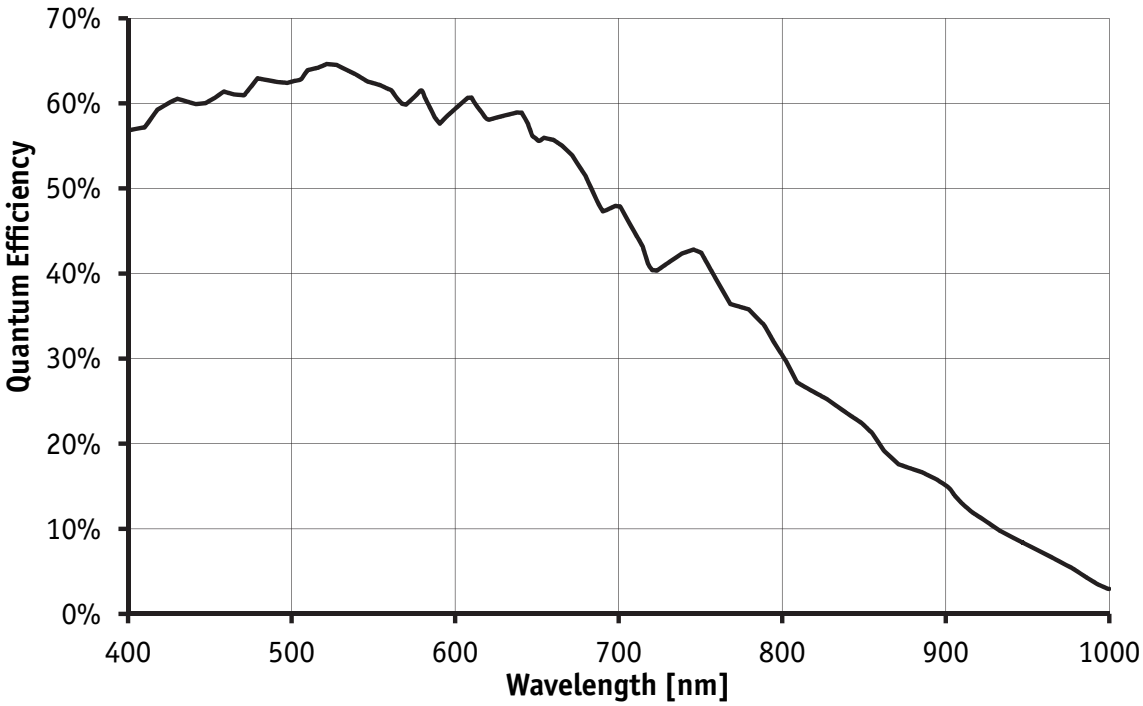



Figure 17: Spectral sensitivity of Mako G-131B

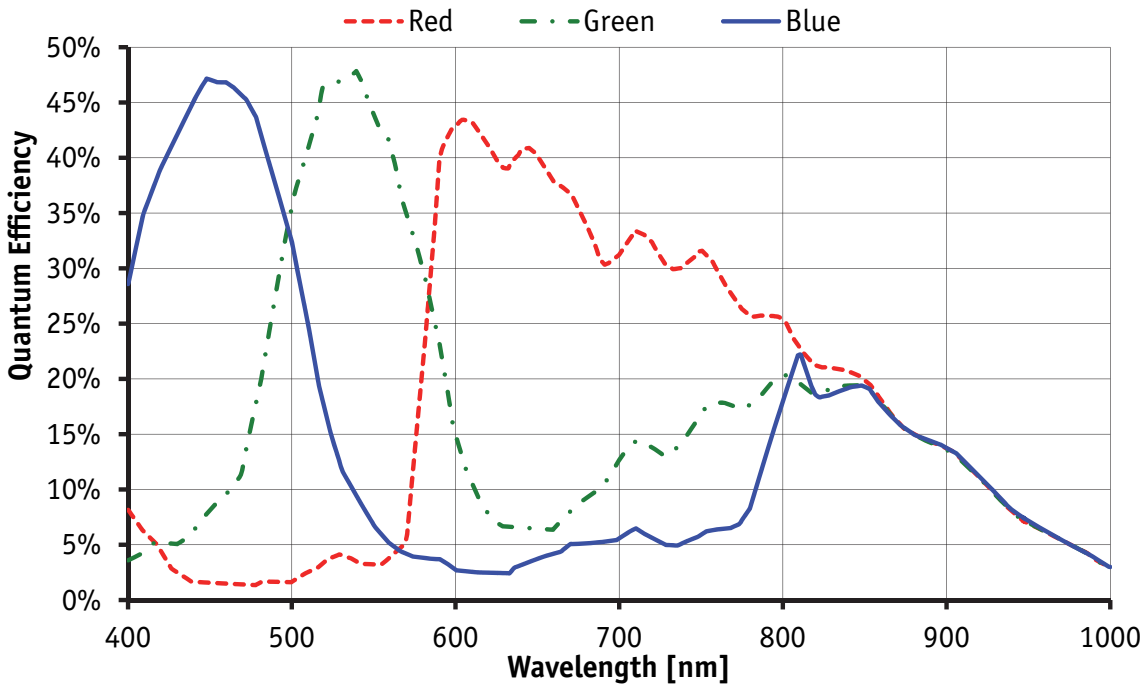



Figure 18: Spectral sensitivity of Mako G-131C

# Mako G-192B/C

| Feature | Specification | | |
|---|---|---|---|
| Resolution | 1600 x 1200 | | |
| Sensor | e2v EV76C570 | | |
| Type | CMOS Progressive | | |
| Sensor size | Type 1/1.8 | | |
| Cell size | 4.5 µm | | |
| Lens mount | C / CS-Mount | | |
| Max frame rate at full resolution | 60 fps | | |
| Max image bit depth | 10 bit | | |
| On-board FIFO | 64 MByte, up to 34 frames at full resolution, Mono8/Bayer8, and a *GevSCP-SPacketSize* = 8192 bytes per packet | | |
| Mono formats | Mono8, Mono10 | | |
| Color formats | BayerGB8, BayerGB10, Mono 8, RGB8Packed, BGR8Packed, YUV411Packed, YUV422Packed, YUV444Packed | | |
| Exposure control | PixelFormat | ShutterMode: Global / Rolling | ShutterMode: GlobaReset |
| | Mono8, Mono10, BayerGB8, BayerGB10, YUV411Packed, YUV422Packed | 14 µs to 0.891 s | 14 µs to 0.874 s |
| | RGB8Packed, BGR8Packed, YUV444Packed | 14 µs to 1.870 s | 14 µs to 1.835 s |
| Gain control | 0–24 dB | | |
| Binning | Horizontal: 1 to 2 pixels; Vertical: 1 to 2 rows | | |
| Decimation | Horizontal and Vertical: 1, 2, 4, 8 factor | | |
| Opto-coupled I/Os | 1 input, 3 outputs | | |
| Voltage requirements | 12–24 VDC or PoE | | |
| Power consumption | 2.1 W @ 12 VDC, 2.4 W PoE | | |
| Trigger latency* | Idle state: 27.7 µs<br>Frame valid state: 27.7 µs | | |
| Trigger jitter* | Idle state: 6.9 µs<br>Frame valid state: 6.9 µs | | |
| Operating temperature | +5 °C to +45 °C (housing temperature) | | |
| Storage temperature | -10 °C to +70 °C ambient temperature (without condensation) | | |
| Body dimensions (L x W x H) | 60.5 x 29 x 29 mm; including connectors, without tripod and lens | | |
| Mass | 80 g (without lens) | | |
| Hardware interface standard | PoE, IEEE 802.3af 1000BASE-T, 100BASE-TX | | |
| Software interface standard | GigE Vision Standard 1.2 | | |
| Camera control interface | GenICam V1.0 compliant | | |
| Regulatory | CE, FCC Class B, RoHS (2011/65/EU), WEEE | | |
| *These values are calculated directly from the microcontroller source. These values are only valid for pixel formats < 16 bit per pixel and applicable in both Idle and Frame valid state:<br>– Idle state: sensor is ready and camera is idle, waiting for the next trigger<br>– Frame valid state: sensor is reading out and camera is busy. If the next frame is requested by an external trigger in this state, higher latency may occur as compared to the Idle state | | | |

Table 9: Mako G-192B/C camera specifications

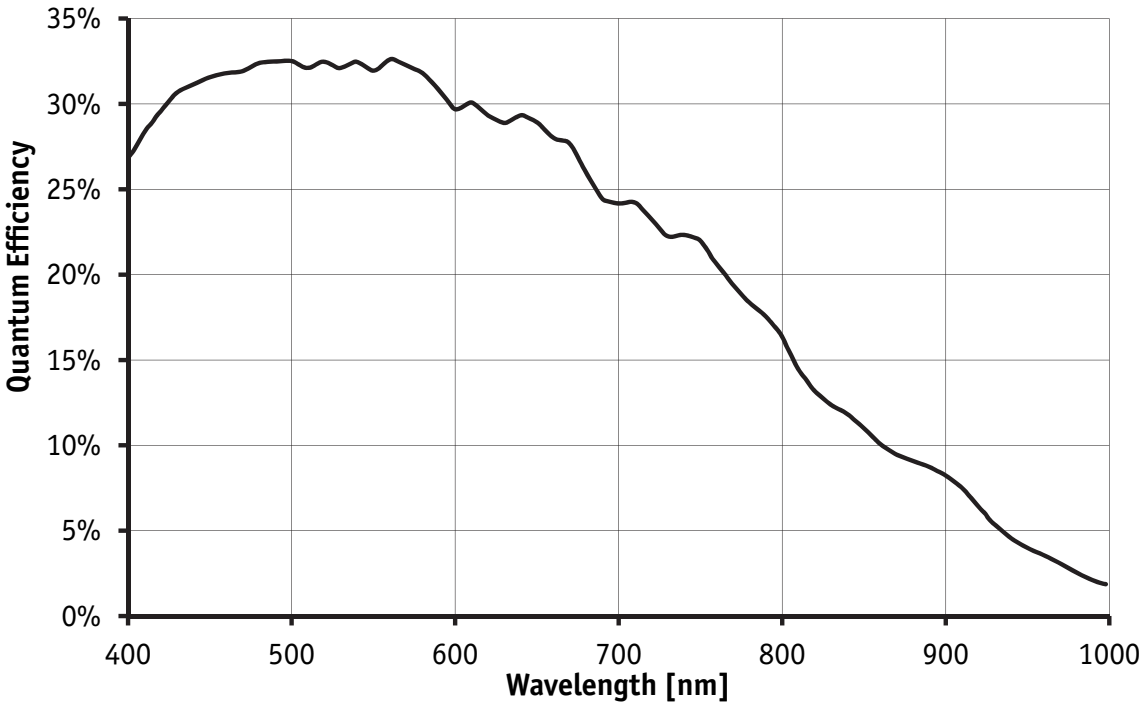



Figure 19: Spectral sensitivity of Mako G-192B

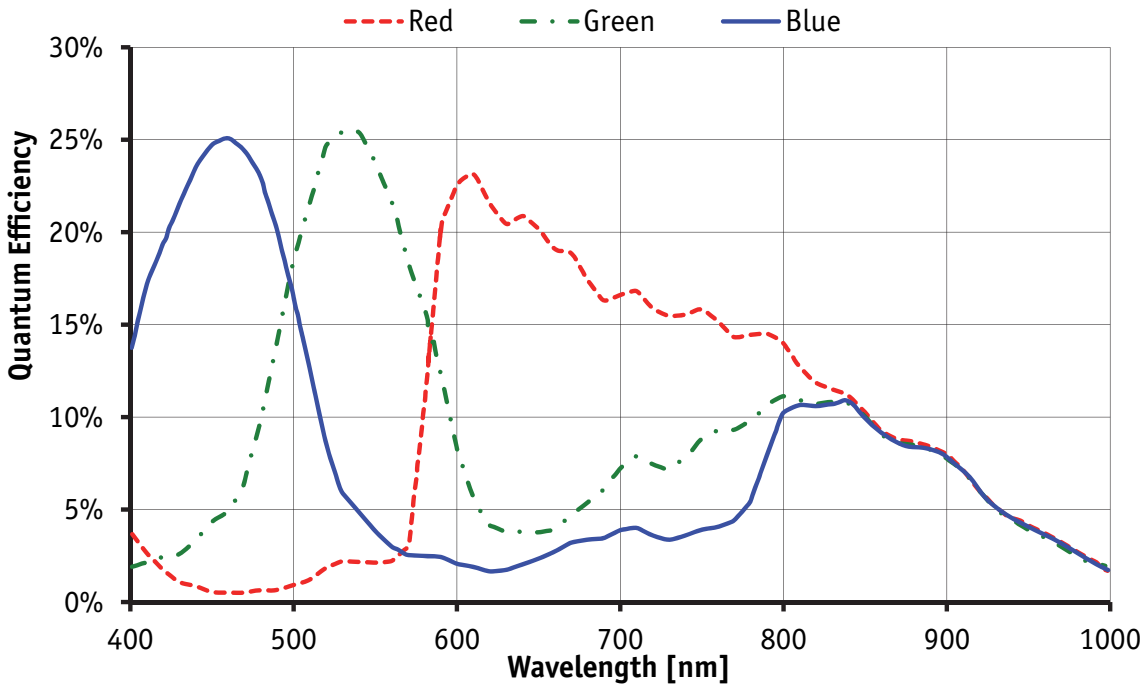



Figure 20: Spectral sensitivity of Mako G-192C

# Mako G-223B/C (NIR)

| Feature | Specification |
|---|---|
| Resolution | 2048 x 1088 |
| Sensor | CMV2000 with microlenses and global shutter |
| Type | CMOS |
| Sensor size | Type 2/3 |
| Cell size | 5.5 µm |
| Lens mount | C / CS-Mount |
| Max frame rate at full resolution | 49.5 fps |
| Max image bit depth | 12 bit |
| On-board FIFO | 64 MByte, up to 29 frames at full resolution, Mono8/Bayer8, and a *GevSCPSPacketSize* = 8192 bytes per packet |
| Mono formats | Mono8, Mono12Packed, Mono12 |
| Color formats | BayerGB8, BayerGB12, BayerGB12Packed, Mono8, RGB8Packed, BGR8Packed, RGBA8Packed, BGRA8Packed, YUV411Packed, YUV422Packed, YUV444Packed |
| Exposure control | 21 µs† to 153 s |
| Gain control | 0–26 dB |
| Opto-coupled I/Os | 1 input, 3 outputs |
| Voltage requirements | 12–24 VDC or PoE |
| Power consumption | 2.4 W @ 12 VDC, 2.8 W PoE |
| Trigger latency | N/A |
| Trigger jitter | N/A |
| Operating temperature | +5 °C to +45 °C (housing temperature) |
| Storage temperature | -10 °C to +70 °C ambient temperature (without condensation) |
| Body dimensions (L x W x H) | 60.5 x 29 x 29 mm; including connectors, without tripod and lens |
| Mass | 80 g (without lens) |
| Hardware interface standard | PoE, IEEE 802.3af 1000BASE-T, 100BASE-TX |
| Software interface standard | GigE Vision Standard 1.2 |
| Camera control interface | GenICam V1.0 compliant |
| Regulatory | CE, FCC Class B, RoHS (2011/65/EU), WEEE |
| †Camera firmware v1.52.8151 shows minimum exposure values without frame overhead time, i.e., 1 µs. See sensor datasheet for details on frame overhead time. This will be fixed in the next firmware release. | |

Table 10: Mako G-223 B/C (NIR) camera specifications

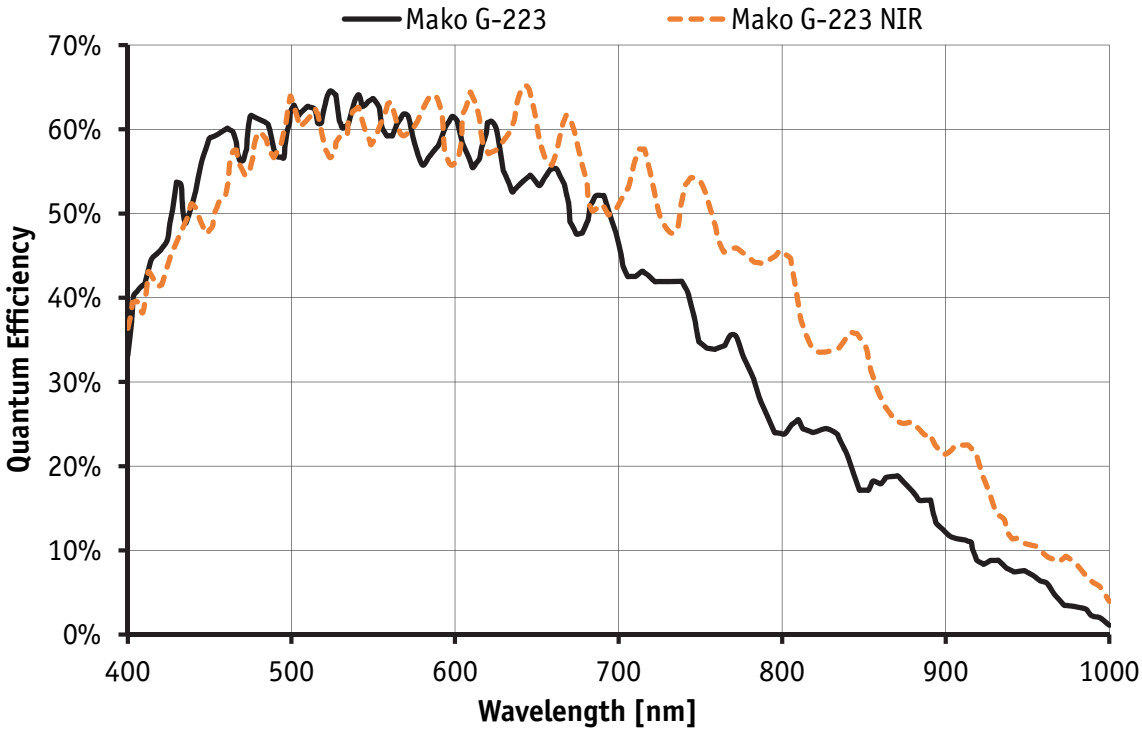



Figure 21: Spectral sensitivity of Mako G-223B (NIR)

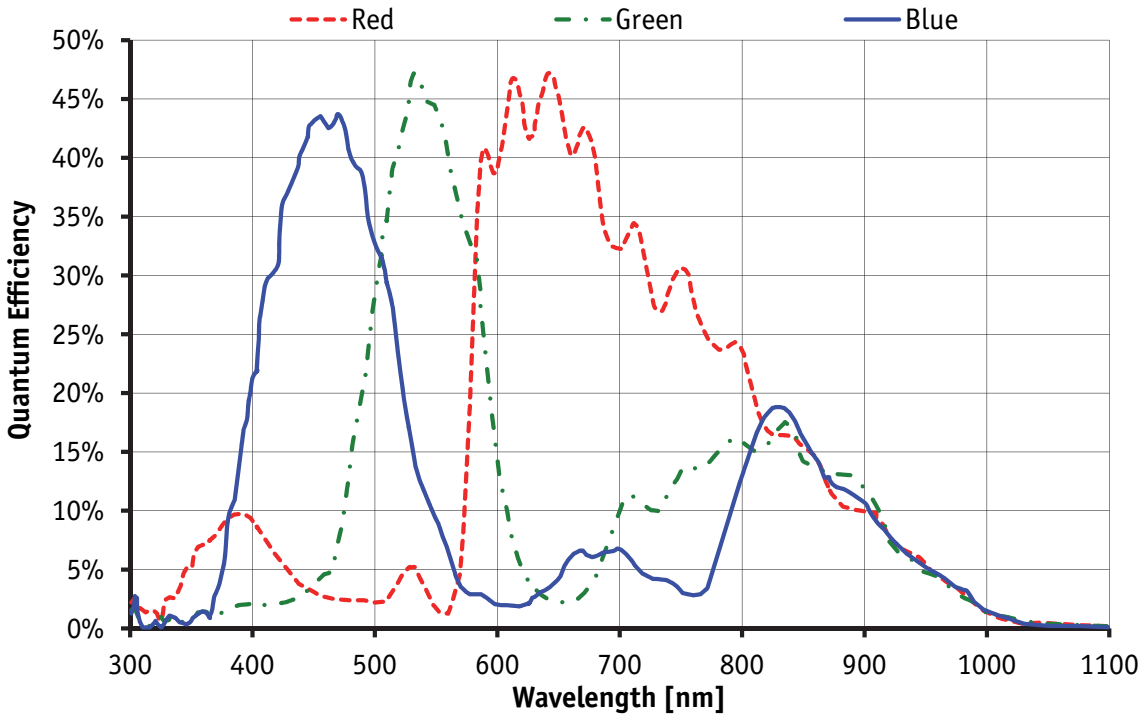



Figure 22: Spectral sensitivity of Mako G-223C (without IR cut filter)

# Mako G-419B/C (NIR)

| Feature | Specification |
|---|---|
| Resolution | 2048 x 2048 |
| Sensor | CMV4000 with microlenses and global shutter |
| Type | CMOS |
| Sensor size | Type 1 |
| Cell size | 5.5 µm |
| Lens mount | C / CS-Mount |
| Max frame rate at full resolution | 26.3 fps |
| Max image bit depth | 12 bit |
| On-board FIFO | 64 MByte, up to 15 frames at full resolution, Mono8/Bayer8, and a *GevSCPSPacketSize* = 8192 bytes per packet |
| Mono formats | Mono8, Mono12Packed, Mono12 |
| Color formats | BayerGB8, BayerGB12, BayerGB12Packed, Mono8, RGB8Packed, BGR8Packed, RGBA8Packed, BGRA8Packed, YUV411Packed, YUV422Packed, YUV444Packed |
| Exposure control | 41 µs† to 153 s |
| Gain control | 0–26 dB |
| Opto-coupled I/Os | 1 input, 3 outputs |
| Voltage requirements | 12–24 VDC or PoE |
| Power consumption | 2.3 W @ 12 VDC, 2.7 W PoE |
| Trigger latency | N/A |
| Trigger jitter | N/A |
| Operating temperature | +5 °C to +45 °C (housing temperature) |
| Storage temperature | -10 °C to +70 °C ambient temperature (without condensation) |
| Body dimensions (L x W x H) | 60.5 x 29 x 29 mm; including connectors, without tripod and lens |
| Mass | 80 g (without lens) |
| Hardware interface standard | PoE, IEEE 802.3af 1000BASE-T, 100BASE-TX |
| Software interface standard | GigE Vision Standard 1.2 |
| Camera control interface | GenICam V1.0 compliant |
| Regulatory | CE, FCC Class B, RoHS (2011/65/EU), WEEE |
| †Camera firmware v1.52.8151 shows minimum exposure values without frame overhead time, i.e., 1 µs. See sensor datasheet for details on frame overhead time. This will be fixed in the next firmware release. | |

Table 11: Mako G-419 B/C (NIR) camera specifications

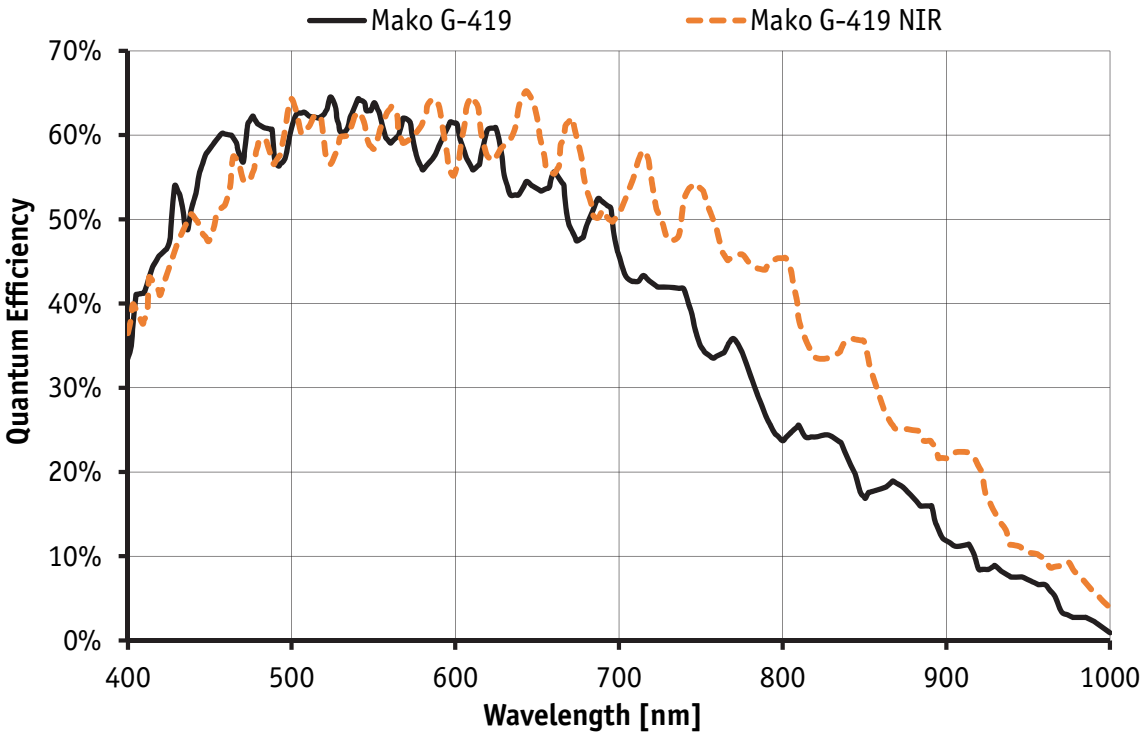



Figure 23: Spectral sensitivity of Mako G-419B (NIR)

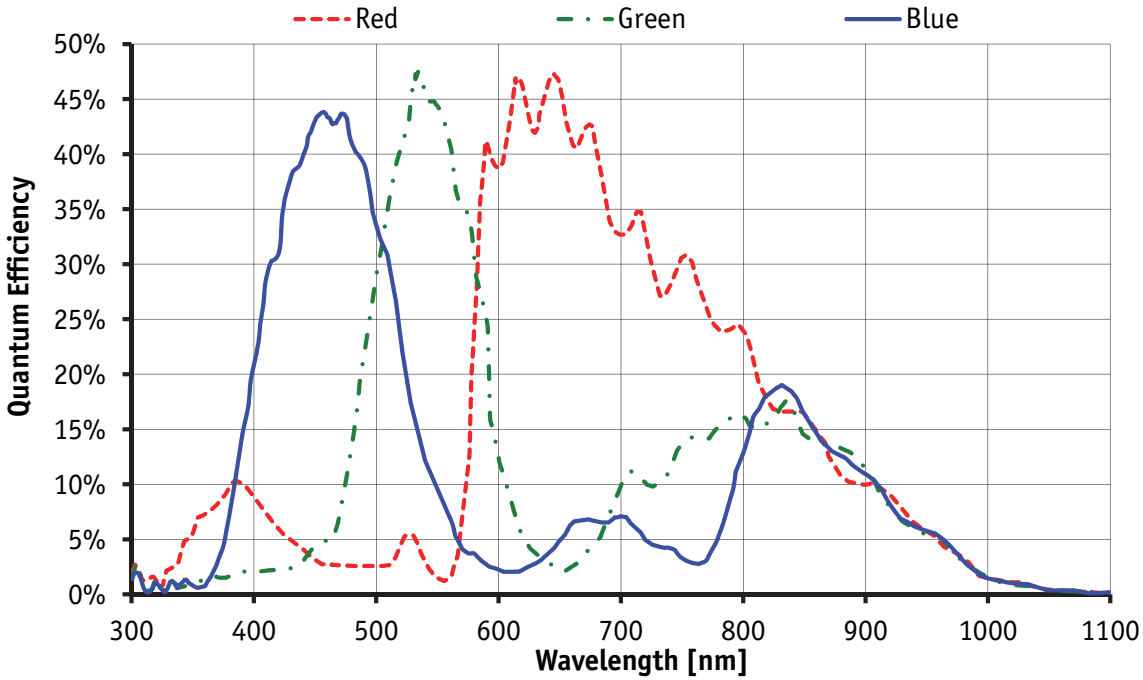



Figure 24: Spectral sensitivity of Mako G-419C (without IR cut filter)

# Camera smart features

Allied Vision cameras support a number of standard and extended features. The table below identifies a selection of interesting capabilities of the Mako camera family.

**www**

A complete listing of camera controls, including control definitions can be found online:

**PvAPI users:** GigE Camera and Driver Attributes document

**VIMBA and third-party users:** GigE Camera and Driver Features document

| Control | Description |
|---|---|
| Gain control | Manual and auto |
| Exposure control | Manual and auto |
| White balance | Red and blue channel; manual and auto control |
| External trigger event | Rising edge, falling edge, any edge, level high, level low |
| Imaging modes | Free-running, external trigger, fixed rate, software trigger |
| Sync out modes | Trigger ready, trigger input, exposing, readout, imaging, strobe, GPO |
| Region of interest | Independent x and y control with 1 pixel resolution |
| Multicast | Streaming to multiple computers |
| Event channel | In-camera events including exposure start and trigger are asynchronously broadcasted to the host computer |
| Chunk data | Captured images are bundled with attribute information such as exposure and gain value |
| Color correction matrix | Correct color rendering for specific color temperature |
| Gamma, Hue, Saturation | Adjust image gamma, hue, and saturation |
| Look-up table (LUT) | LUTs available on all models |
| Temperature monitoring | Monitor camera temperature: resolution 0.031, accuracy ±1 °C |
| Decimation | Sub-sampling available on select models |
| Mirroring | ReverseX and ReverseY available on select models |
| Binning | Different binning modes available on select models: Average and Sum |
| Sensor shutter modes | Different shutter modes available on select models: Global, Rolling and GlobalReset |
| HDR mode | Available on Mako G-030 |
| Defect pixel correction | Available on select models |

Table 12: Mako camera smart features

# Filter and lenses

## IR cut filter

**Color** cameras are equipped with **IR cut filter**. The following illustration shows the spectral transmission of the IR cut filter:

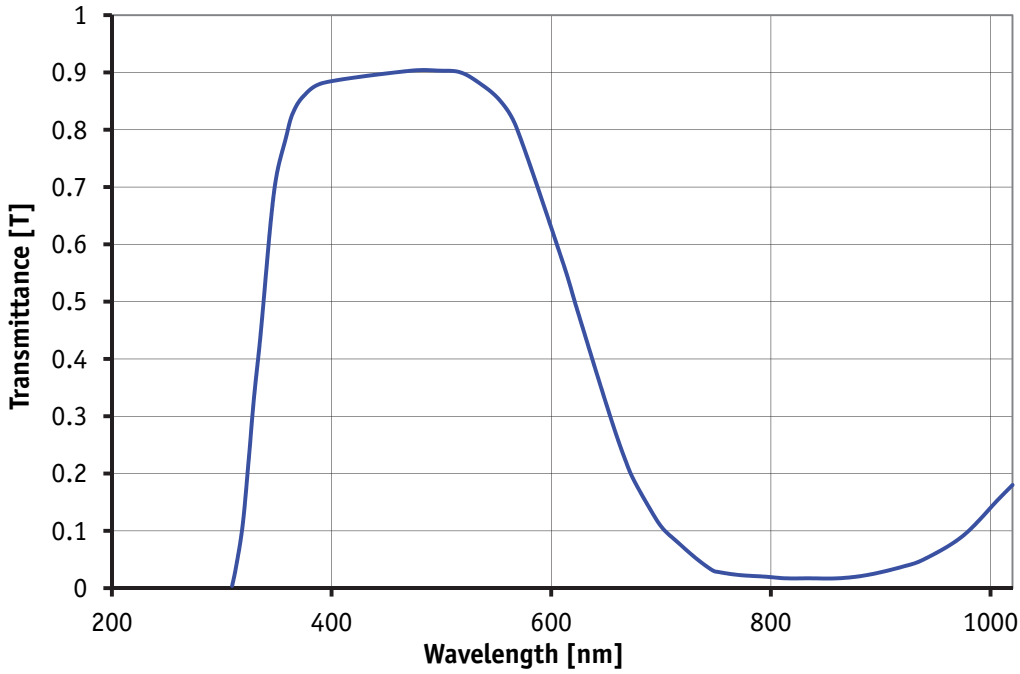



Figure 25: Approximate spectral transmission of IR cut filter (may vary slightly by filter lot) (type Hoya C5000)

## Camera lenses

Allied Vision offers different lenses from a variety of manufacturers.

**www**

For more information, see:

http://www.alliedvisiontec.com/emea/products/accessories/lenses.html

The following table lists selected image formats in **width x height** depending on camera type, distance and the focal length of the lens.

**Note**

- Lenses with focal lengths < 8 mm may show shading in the edges of the image due to microlenses on the sensor.
- The exact values vary and depend on the respective lens.

## Mako G-030

| Focal length for type 1/3 sensor | Distance = 500 mm | Distance = 1000 mm |
|---|---|---|
| 4.8 mm | 495mm x 371 mm | 995 mm x746 mm |
| 8 mm | 295 mm x 221 mm | 595 mm x446 mm |
| 12.5 mm | 187mm x 140 mm | 379 mm x284 mm |
| 16 mm | 145 mm x 109 mm | 295 mm x221 mm |
| 25 mm | 91 mm x 68 mm | 187 mm x140 mm |
| 50 mm | 43 mm x 32 mm | 91 mm x68 mm |

Table 13: Focal length vs. field of view (Mako G-030)

## Mako G-032

| Focal length for type 1/3 sensor | Distance = 500 mm | Distance = 1000 mm |
|---|---|---|
| 4.0 mm | 608 mm x 446 mm | 1220 mm x 896 mm |
| 4.8 mm | 506 mm x 371 mm | 1016 mm x 746 mm |
| 8 mm | 301 mm x 221 mm | 608 mm x 446 mm |
| 12 mm | 199 mm x 146 mm | 403 mm x 296 mm |
| 16 mm | 148 mm x 109 mm | 301 mm x 221 mm |
| 25 mm | 93 mm x 68 mm | 191 mm x 140 mm |
| 35 mm | 65 mm x 48 mm | 135 mm x 99 mm |

Table 14: Focal length vs. field of view (Mako G-032)

## Mako G-050

| Focal length for type 1/3 sensor | Distance = 500 mm | Distance = 1000 mm |
|---|---|---|
| 4 mm | 604 mm x 457 mm | 1213 mm x 917 mm |
| 6 mm | 401 mm x 303 mm | 807 mm x 610 mm |
| 8 mm | 300 mm x 227 mm | 604 mm x 457 mm |
| 10 mm | 239 mm x 181 mm | 482 mm x 365 mm |
| 12 mm | 198 mm x 150 mm | 401 mm x 303 mm |
| 16 mm | 147 mm x 111 mm | 300 mm x 227 mm |
| 25 mm | 93 mm x 70 mm | 190 mm x 144 mm |

Table 15: Focal length vs. field of view (Mako G-050)

## Mako G-095

| Focal length for type 1/3 sensor | Distance = 500 mm | Distance = 1000 mm |
|---|---|---|
| 4 mm | 654 mm x 371 mm | 1313 mm x 746 mm |
| 6 mm | 434 mm x 247 mm | 873 mm x 496 mm |
| 8 mm | 324 mm x 184 mm | 654 mm x 371 mm |
| 10 mm | 258 mm x 147 mm | 522 mm x 296 mm |
| 12 mm | 214 mm x 122 mm | 434 mm x 247 mm |
| 16 mm | 159 mm x 91 mm | 324 mm x 184 mm |
| 25 mm | 100 mm x 57 mm | 206 mm x 117 mm |

Table 16: Focal length vs. field of view (Mako G-095)

## Mako G-125

| Focal length for type 1/3 sensor | Distance = 500 mm | Distance = 1000 mm |
|---|---|---|
| 4.0 mm | 595 mm x 446 mm | 1195 mm x 896 mm |
| 4.8 mm | 495 mm x 371 mm | 995 mm x 746 mm |
| 8 mm | 295 mm x 221 mm | 595 mm x 446 mm |
| 12 mm | 195 mm x 146 mm | 395 mm x 296 mm |
| 16 mm | 145 mm x 109 mm | 295 mm x 221 mm |
| 25 mm | 91 mm x 68 mm | 187 mm x 140 mm |
| 35 mm | 64 mm x 48 mm | 132 mm x 99 mm |

Table 17: Focal length vs. field of view (Mako G-125)

## Mako G-131

| Focal length for type 1/1.8 sensor | Distance = 500 mm | Distance = 1000 mm |
|---|---|---|
| 4.5 mm | 760 mm x 606 mm | 1526 mm x1 217 mm |
| 6 mm | 568 mm x 453 mm | 1143 mm x 911 mm |
| 10 mm | 338 mm x 270 mm | 683 mm x 545 mm |
| 17 mm | 196 mm x 156 mm | 399 mm x 318 mm |
| 25 mm | 131 mm x 105 mm | 269 mm x 215 mm |
| 35 mm | 92 mm x 73 mm | 190 mm x 152 mm |

Table 18: Focal length vs. field of view (Mako G-131)

## Mako G-192

| Focal length for type 1/1.8 sensor | Distance = 500 mm | Distance = 1000 mm |
|---|---|---|
| 4.5 mm | 793 mm x 595 mm | 1593 mm x 1195 mm |
| 6 mm | 593 mm x 445 mm | 1193 mm x 895 mm |
| 10 mm | 353 mm x 265 mm | 713 mm x 535 mm |
| 17 mm | 205 mm x 153 mm | 416 mm x 312 mm |
| 25 mm | 137 mm x 103 mm | 281 mm x 211 mm |
| 35 mm | 793 mm x 595 mm | 1593 mm x 1195 mm |

Table 19: Focal length vs. field of view (Mako G-192)

## Mako G-223

| Focal length for type 2/3*sensors | Distance = 500 mm | Distance = 1000 mm |
|---|---|---|
| 4.8 mm | 1162 mm x 617 mm | 2335 mm x 1240 mm |
| 6 mm | 927 mm x 492 mm | 1865 mm x 991 mm |
| 6.5 mm | 855 mm x 454 mm | 1721 mm x 914 mm |
| 8 mm | 692 mm x 368 mm | 1396 mm x 742 mm |
| 10 mm | 552 mm x 293 mm | 1114 mm x 597 mm |
| 12 mm | 458 mm x 243 mm | 927 mm x 492 mm |
| 16 mm | 341 mm x 181 mm | 692 mm x 369 mm |
| 25 mm | 214 mm x 114 mm | 439 mm x 223 mm |
| 35 mm | 150 mm x 79 mm | 310 mm x 165 mm |
| 50 mm | 101 mm x 54 mm | 214 mm x 114 mm |
| 75 mm | 64 mm x 34 mm | 139 mm x 74 mm |
| 90 mm | 51 mm x 27 mm | 114 mm x 60 mm |

* A 2/3 inch lens may cause vignetting (1 inch lens recommended)

Table 20: Focal length vs. field of view (Mako G-223)

## Mako G-419

| Focal length for type 1 sensors | Distance = 500 mm | Distance = 1000 mm |
|---|---|---|
| 8 mm | 692 mm x 692mm | 1396 mm x 1396 mm |
| 10 mm | 552 mm x 552 mm | 1114 mm x 1114 mm |
| 12 mm | 458 mm x 458 mm | 928 mm x 928 mm |
| 16 mm | 340 mm x 340 mm | 692 mm x 692 mm |
| 25 mm | 214 mm x 214 mm | 439 mm x 439 mm |
| 35 mm | 150 mm x 150 mm | 310 mm x 310 mm |
| 50 mm | 101 mm x 101 mm | 214 mm x 214 mm |
| 75 mm | 64 mm x 64 mm | 139 mm x 139 mm |
| 90 mm | 51 mm x 51 mm | 104 mm x 104 mm |

Table 21: Focal length vs. field of view (Mako G-419)

# Camera dimensions

**Note**

For information on **sensor position accuracy** (sensor shift x/y, optical back focal length z and sensor rotation α):

see Appendix on page 76.

## Tripod adapter

This tripod adapter (Allied Vision order number 4807) ...

- ... can be used for Mako cameras.
- ... is only designed for standard housings.

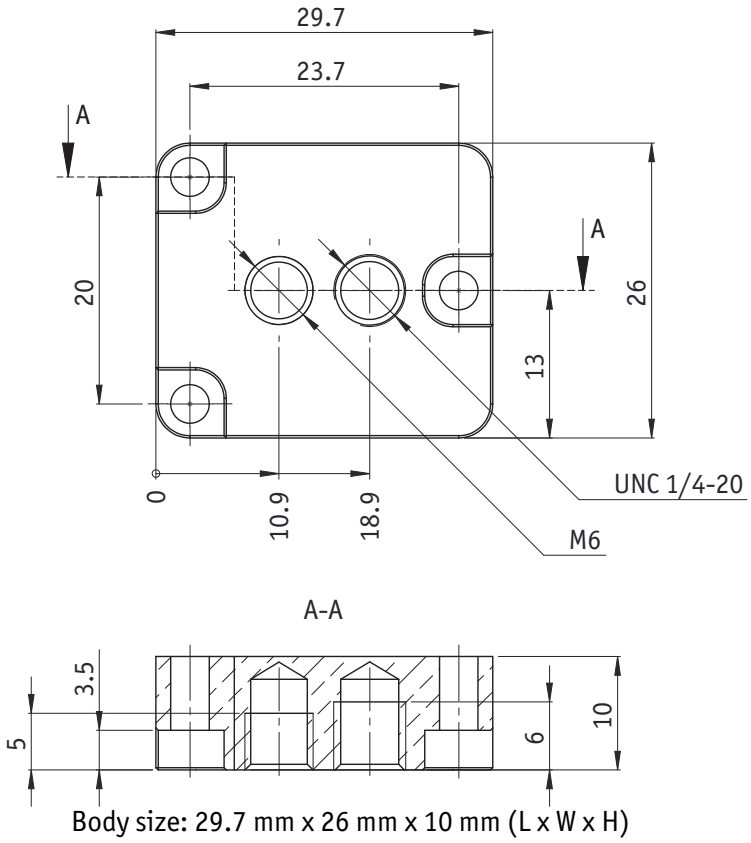



Figure 26: Tripod adapter dimensions

# Cross section: C-Mount

**www**

Choose protection glass or filter according to the **Modular Camera Concept:**

http://www.alliedvisiontec.com/us/support/downloads/product-literature/avt-modular-concept.html

**Note**

Monochrome Mako cameras with serial number 536873083 or higher are shipped without a cover ring in the C-Mount thread. Refer to product change notice for more details.

- All color Mako cameras are equipped with the same IR cut filter type.
- Mako G-030, Mako G-032, Mako G-050, Mako G-095, Mako G-125, Mako G-131, and Mako G-192 are equipped with a 16 mm diameter filter.

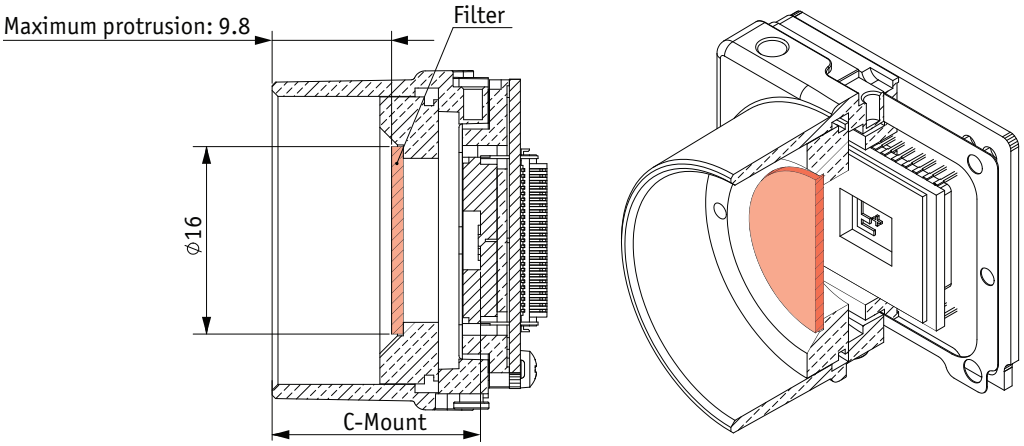



Figure 27: C-Mount dimensions for Mako G-030 / G-032 / G-050 / G-095 / G-125 / G-131 / G-192 (16 mm filter)

- Mako G-223 and Mako G-419 are equipped with a 22 mm diameter filter.

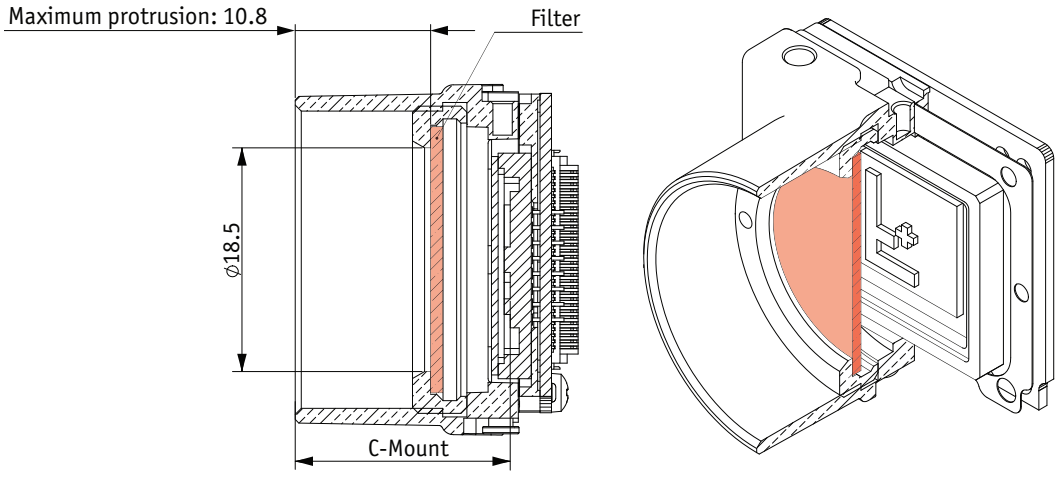



Figure 28: C-Mount dimensions for Mako G-223 / G-419 (22 mm filter)

# Cross section: CS-Mount

Choose protection glass or filter according to the **Allied Vision Modular Concept**.

**www** Download the **Modular Concept** at:

http://www.alliedvisiontec.com/emea/support/downloads/product-literature.html

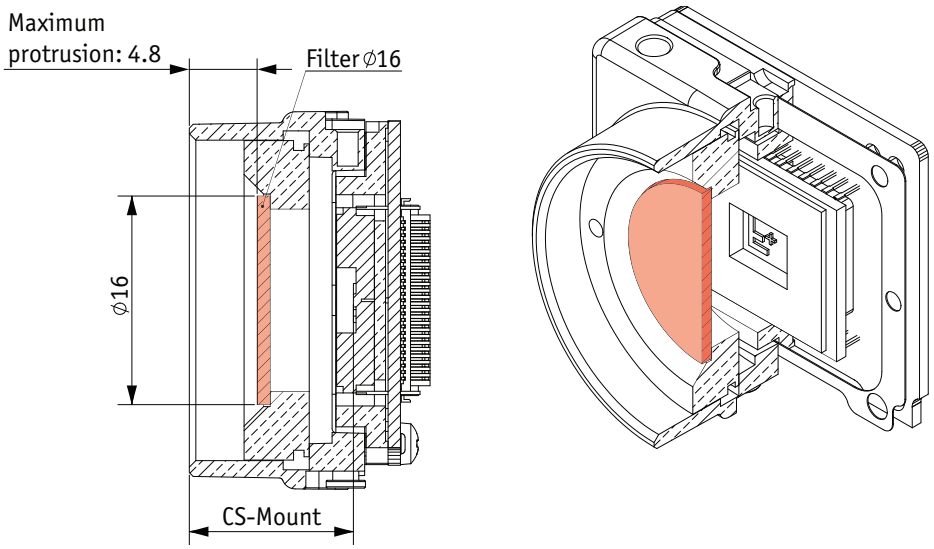



Figure 29: CS-Mount dimensions for Mako G-030 / G-032 / G-050 / G-095 / G-125 / G-131 / G-192 (16 mm filter)

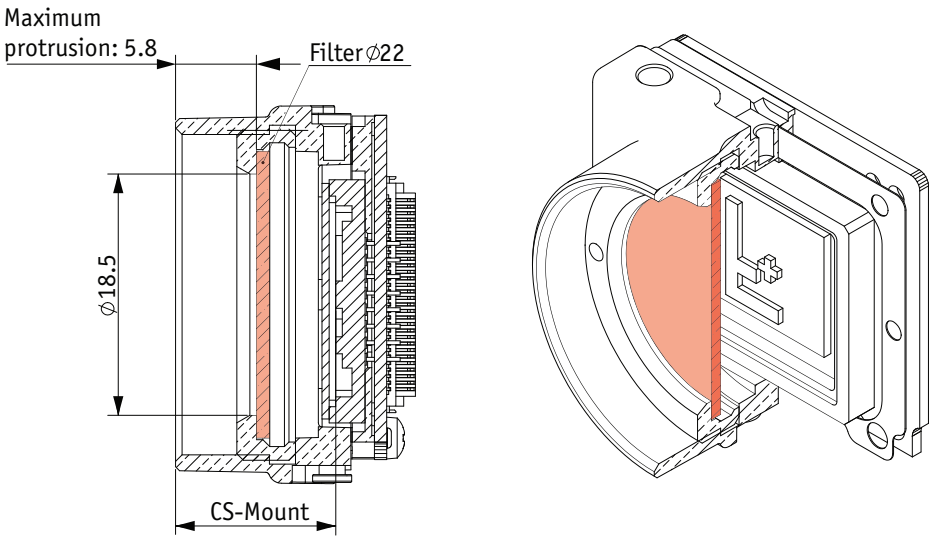



Figure 30: CS-Mount dimensions for Mako G-223 /G-419 (22 mm filter)

# Adjustment of the C-Mount and CS-Mount

The dimensional adjustment cannot be done by the customer. All modifications have to be done by the Allied Vision factory.

**Note**

**If you need any adjustments, please contact Customer Care:**
For phone numbers and e-mail:

see Contacting Allied Vision on page 5.

# Mako standard housing

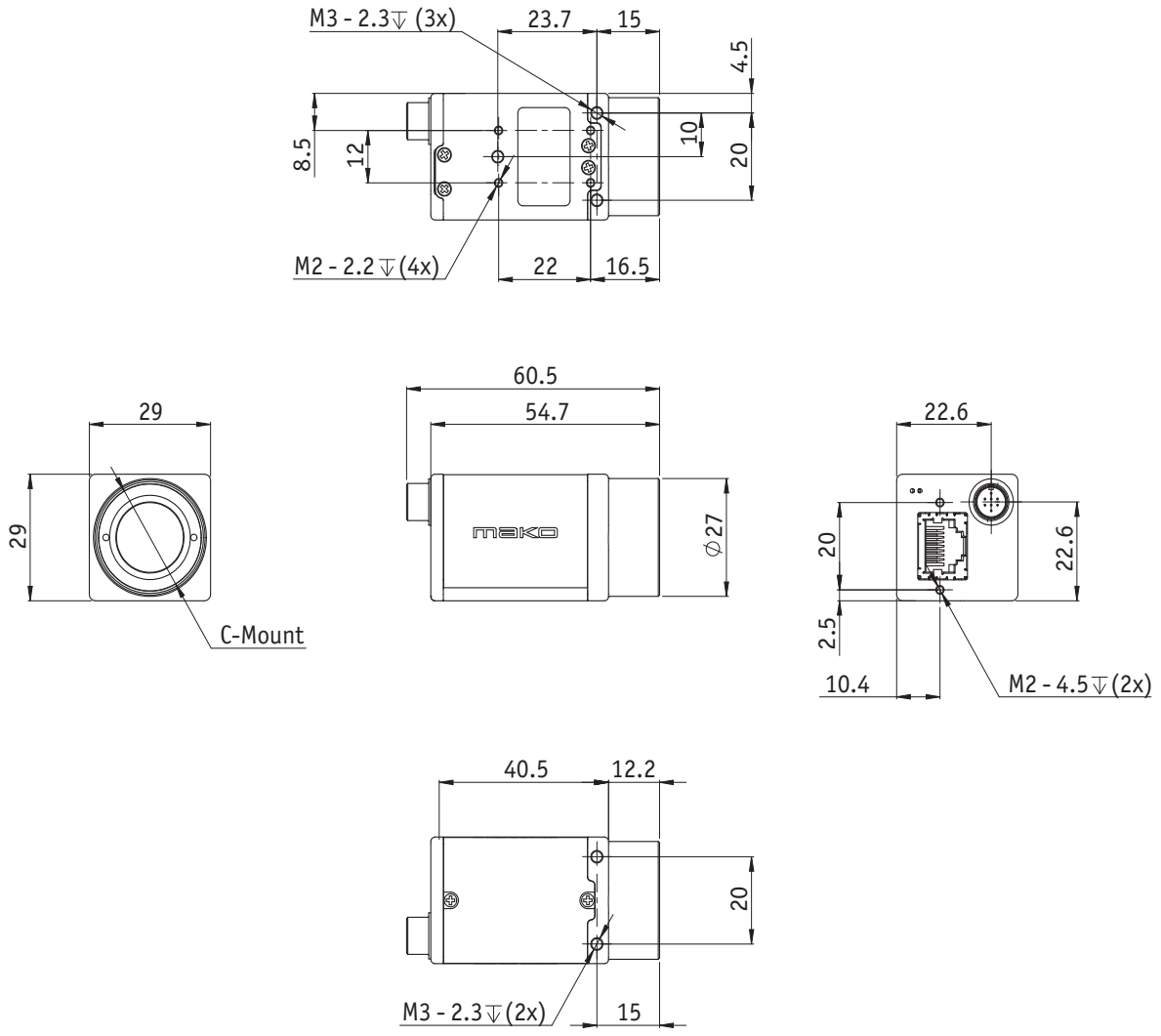



Figure 31: Camera dimensions standard housing (in mm)

# Camera interfaces

This chapter describes the Gigabit Ethernet port, inputs and outputs, and trigger features.

**Note**

Read all ***Notes*** and ***Cautions*** in the **GigE Installation Manual** before using any interfaces.

**www**

For accessories like cables see:

http://www.alliedvisiontec.com/emea/products/accessories/gige-accessories.html

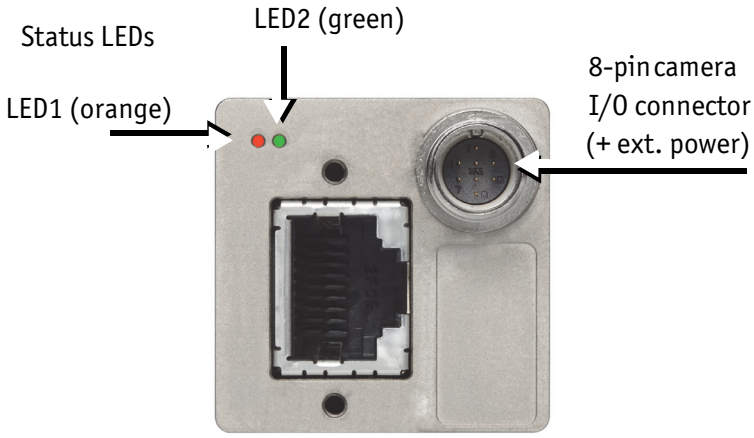



Figure 32: Example: Rear view of **Mako** camera

# Status LEDs

The tables below describe the status LEDs of Mako cameras.

| LED1 color | Status |
|---|---|
| Solid orange | Ethernet link established |
| Flashing orange | Network traffic |

Table 22: Status LED **(orange)**

| LED2 color | Status |
|---|---|
| Solid green | Camera powered |
| Slow flashing green | Booting routine |
| Four rapid flashes per second | Transmission error.<br>Contact support@alliedvision.com |

Table 23: Status LED **(green)**

# Gigabit Ethernet port

The Gigabit Ethernet port conforms to the IEEE 802.31000BASE-T standard for Gigabit Ethernet over copper. To prevent EMI (electromagnetic interference) and for best performance, Category 6 (or higher) cables with S/STP shielding and connectors are recommended. Applications with longer cable lengths or harsh EMI conditions require Category 7 (or higher) cables.

**Note**

- Cable lengths up to 100 m are supported.
- The 8-pin RJ-45 jack provides a pin assignment according to the Ethernet standard (IEEE 802.3 1000BASE-T).
- All Mako cameras are PoE capable (802.3af/at).
- If both interfaces are used for power (I/O and GigE connector via **PoE**), the camera will only use the power from the I/O connector.

**Accessories**

- Cables are available from Allied Vision: http://www.alliedvisiontec.com/emea/products/accessories/gige-accessories.html

# Mako I/O connector pin assignment

| Pin | Signal | Direction | Level | Description |
|---|---|---|---|---|
| 1 | Out 1 | Out | Open emitter, max. 20 mA | Output 1 |
| 2 | Out 2 | Out | Open emitter, max. 20 mA | Output 2 |
| 3 | Out 3 | Out | Open emitter, max. 20 mA | Output 3 |
| 4 | In 1 | In | $U_{in}$(high) = 3.0–24.0 V<br>up to 36 V with external resistor of 3.3 kΩ in series<br>$U_{in}$(low) = 0–1.0 V | Input 1 |
| 5 | Camera In GND | In | --- | GND for input |
| 6 | Camera Out Power | In | Common VCC for outputs max. 30 V DC | Power input for opto-isolated outputs |
| 7 | Camera Power | --- | 12–24 V DC +/- 10% | Camera power supply |
| 8 | Ext GND | --- | GND for ext. Power | External Ground for external Power |

Figure 33: Camera I/O connector pin assignment

The General Purpose I/O port uses a Hirose HR25-7TR-8PA(73) connector on the camera side. The mating cable connector is Hirose HR25-7TP-8S.

**Note**

The cable side Hirose connector is available for purchase from Allied Vision.
P/N: K7600503

# Mako input description

## Mako input block diagram

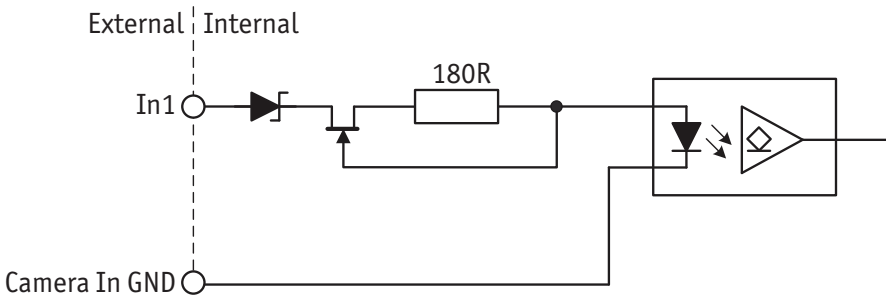



Figure 34: Mako input block diagram

The input can be connected directly to the system for voltages up to 24 V DC. An external resistor is not necessary.

## Mako delay and minimum pulse width

| Parameter | Value |
|---|---|
| $U_{in}$ (low) | 0–1.0 V |
| $U_{in}$ (high) | 3–24 V |
| Current (constant-current source) | 3–4 mA |

Table 24: Mako input parameters

The **minimum pulse width** for all Mako cameras is:

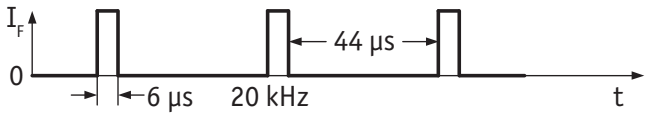



Figure 35: Mako minimum pulse width

### Test conditions

The input signal was driven with 3.3 V and no external additional series resistor.

# Mako output description

## Mako block diagram

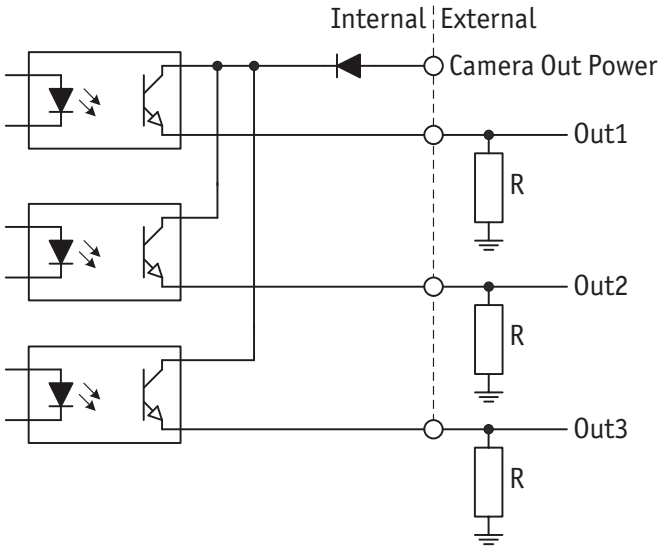



Figure 36: Mako output block diagram

**Caution**

- Maximum 20 mA per output
- **Camera Out Power** > 30 V may damage the camera

| Camera Out Power | Resistor value* | |
|---|---|---|
| 5 V | 1.0 kΩ | at ~ 5 mA minimum required current draw |
| 12 V | 2.4 kΩ | |
| 24 V | 4.7 kΩ | |
| * Resistor required if **Out1/2/3** connected to a device with < 5 mA draw, i.e. high impedance | | |

Figure 37: Mako: Camera Out Power and external resistor

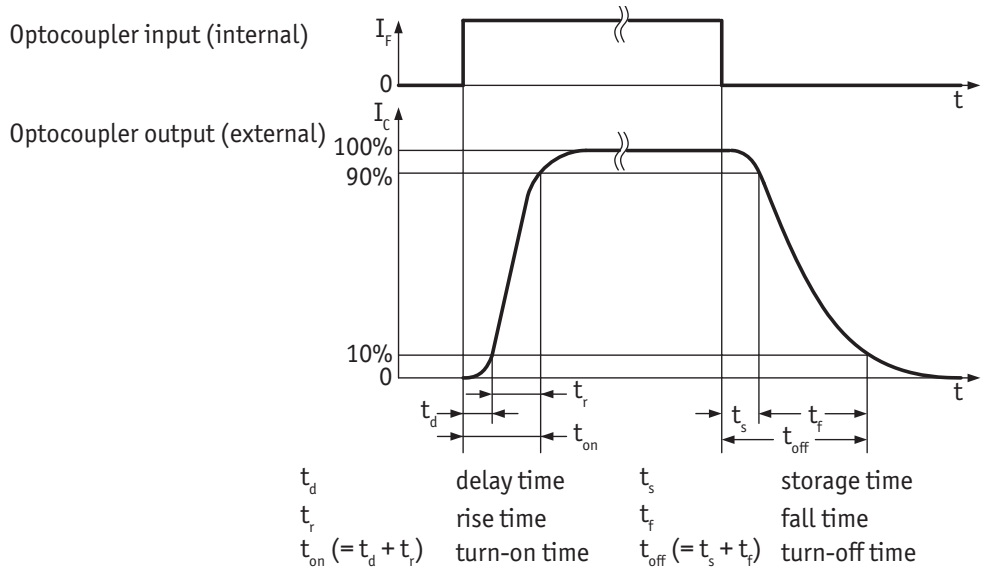



Figure 38: Mako output switching times

For all Mako models:

| Parameter and value | |
|---|---|
| $t_d \approx 1$ µs | $t_s \approx 26$ µs |
| $t_r \approx 1$ µs | $t_f \approx 21$ µs |
| $t_{on} = t_d + t_r \approx 2$ µs | $t_{off} = t_s + t_f \approx 47$ µs<br>($t_{off}$ can deviate by ± 5 µs) |

Table 25: Parameters for Mako

**Test conditions**
Output: external 2.4 kΩ resistor to GND, **Camera Out Power** set to 12 V.

**Note**

Higher external values increase the times in the table above.

**Note**

We recommend to trigger on the rising edge. This guarantees a fastest possible reaction time.

# Control signals

The inputs and outputs of the camera can be configured by software. The different modes are described below.

## Inputs

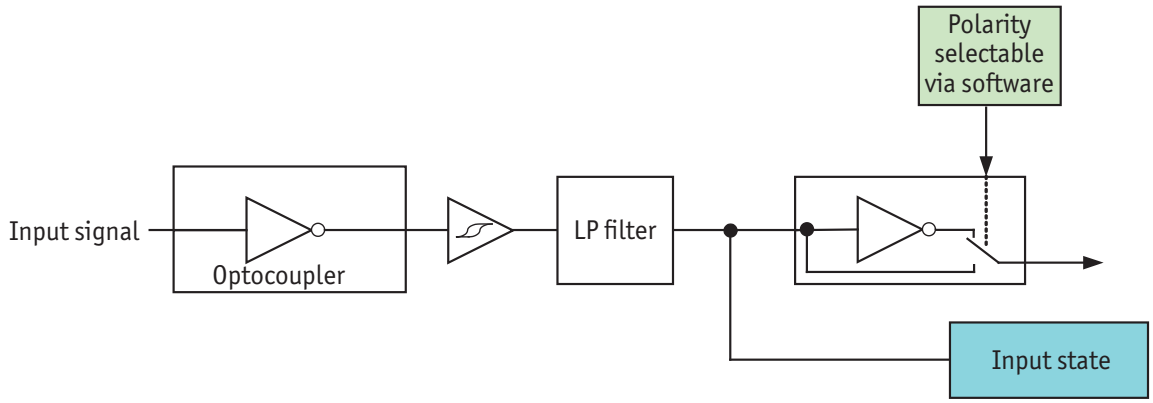



Figure 39: Input block diagram

## Input/output pin control

All input and output signals that pass the I/O connector are controlled by the I/O strobe commands.

## Outputs

Output features are configured by software. Any signal can be placed on any output. The main features of the output signals are described below:

| Signal | Description |
|---|---|
| GPO | Configured to be a general purpose output, control is assigned to SyncOutGpoLevels. |
| AcquisitionTriggerReady | Active once the camera has been recognized by the host PC and is ready to start acquisition. |
| FrameTriggerReady | Active when the camera is in a state that will accept the next frame trigger. |
| FrameTrigger | Active when an image has been initiated to start. This is a logic trigger internal to the camera, which is initiated by an external trigger or software trigger event. |
| Exposing | Exposing – active for the duration of sensor exposure. |
| FrameReadout | Active during frame readout, i.e., the transferring of image data from the CCD to the camera memory. |

Table 26: Output signals

| Signal | Description |
|---|---|
| Imaging | Imaging is high when the camera image sensor is either exposing and/or reading out data. |
| Acquiring | Active during an acquisition stream. |
| SyncIn1 | Active when there is an external trigger at SyncIn1. |
| Strobe1 | The output signal is controlled according to Strobe1 settings. |

Table 26: Output signals

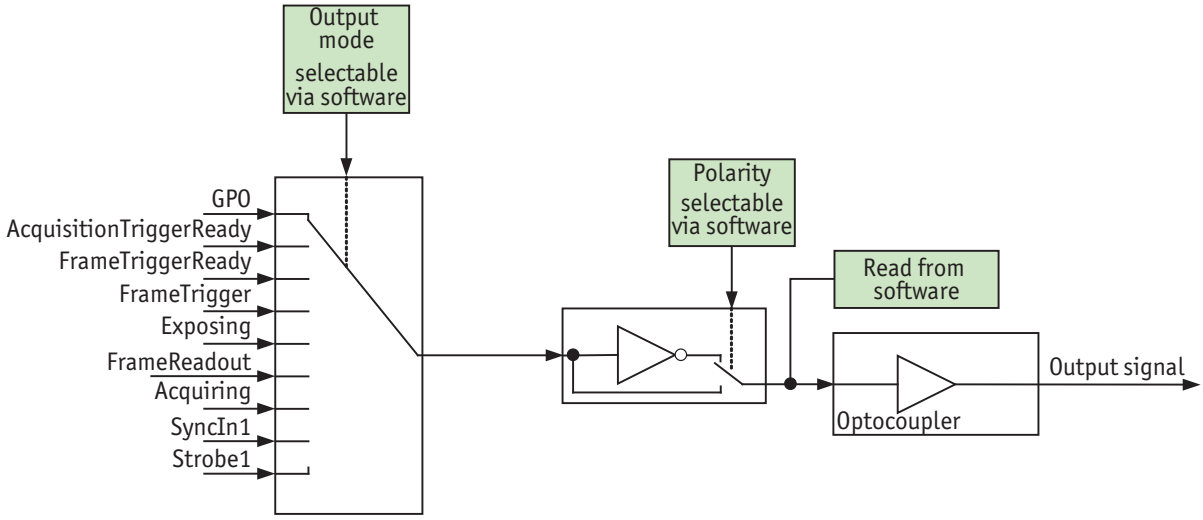



Figure 40: Output block diagram

## Trigger timing diagram

The following diagram explains the trigger concept in general.

**Note** For trigger description on camera control basis, see **GigE Camera and Driver Features**.

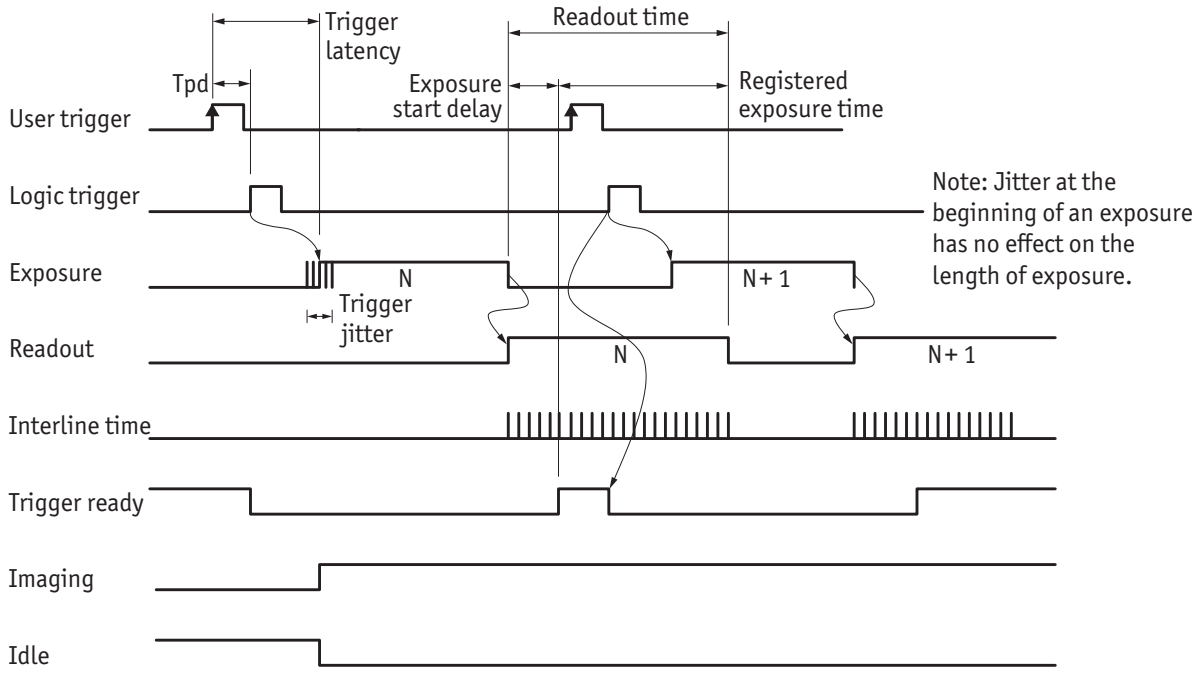



Figure 41: Trigger timing diagram

## Notes on triggering

### Trigger definitions

| Term | Definition |
|---|---|
| User trigger | Trigger signal applied by the user (hardware trigger, software trigger) |
| Logic trigger | Trigger signal seen by the camera internal logic (not visible to the user) |
| Tpd | Propagation delay between the user trigger and the logic trigger |
| Exposure | High when the camera image sensor is integrating light |
| Readout | High when the camera image sensor is reading out data |

Table 27: Trigger definitions

| Term | Definition |
|---|---|
| Trigger latency | Time delay between the user trigger and the start of exposure |
| Trigger jitter | Error in the trigger latency time |
| Trigger ready | Indicates to the user that the camera will accept the next trigger |
| Registered exposure time | Exposure time value currently stored in the camera memory |
| Exposure start delay | Registered exposure time subtracted from the Readout time and indicates when the next exposure cycle can begin such that the exposure will end after the current readout |
| Interline time | Time between sensor row readout cycles |
| Imaging | High when the camera image sensor is either exposing and/or reading out data |
| Idle | High if the camera image sensor is not exposing and/or reading out data |

Table 27: Trigger definitions

### Trigger rules

**Note**

The **user trigger pulse width** should be at least three times the width of the trigger latency as indicated in Specifications chapter on page 16.

- The **end of exposure** will always trigger the next readout.
- The **end of exposure** must always end after the current readout.
- The **start of exposure** must always correspond with the interline time if readout is true.
- **Exposure start delay** equals the readout time minus the registered exposure time.

### Triggering during the Idle State

For applications requiring the shortest possible trigger latency and the smallest possible trigger jitter, the user trigger signal should be applied when imaging is false and idle is true.

### Triggering during the Readout State

For applications requiring the fastest triggering cycle time whereby the camera image sensor is exposing and reading out simultaneously, the user trigger signal should be applied as soon as a valid trigger ready is detected.

In this case, trigger latency and trigger jitter can be up to 1 line time since exposure must always begin on an Interline boundary.

# Description of the data path

The following diagrams illustrate the data flow and the bit resolution of the image data. The individual blocks are described in more detail in the GigE Camera and Driver Features document.

## Mako monochrome cameras

### Mako with CCD sensors

#### Mako G-032B, Mako G-050B, Mako G-095B, Mako G-125B

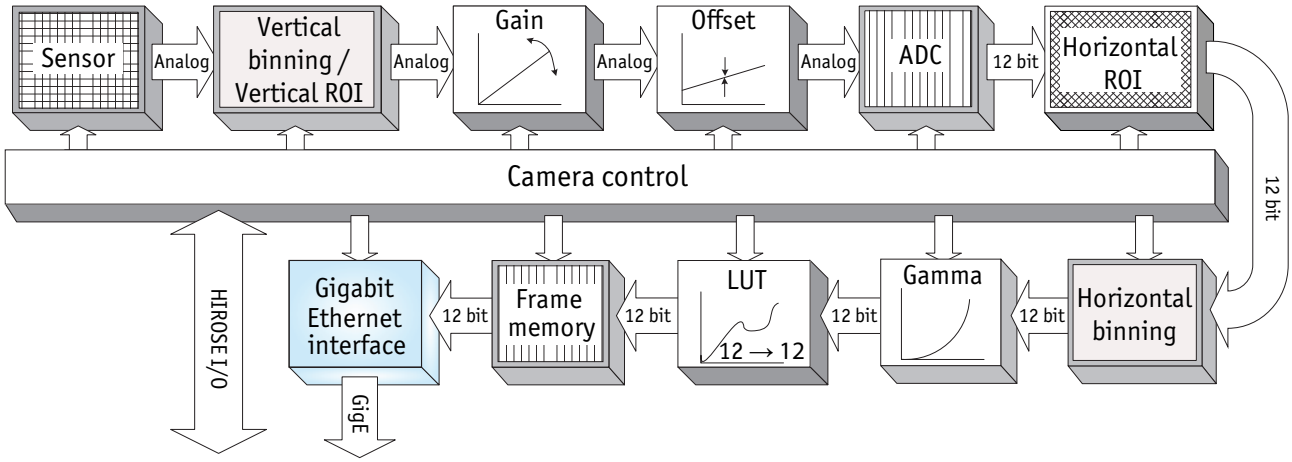



Figure 42: Block diagram of Mako monochrome cameras with CCD sensors

### Mako with CMOS sensors

#### Mako G-030B

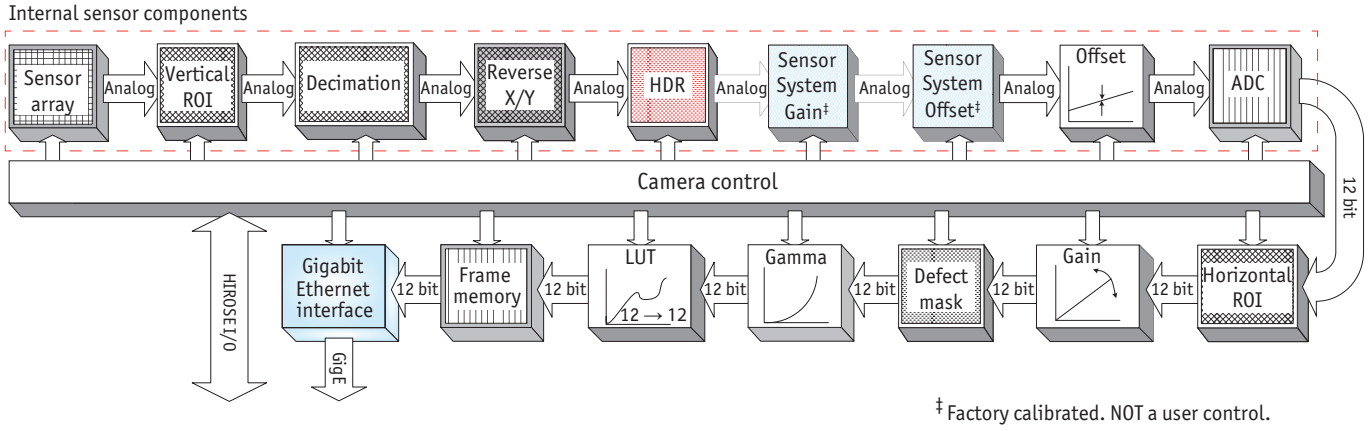



Figure 43: Block diagram of Mako G-030 monochrome cameras

### Mako G-131B, Mako G-192B

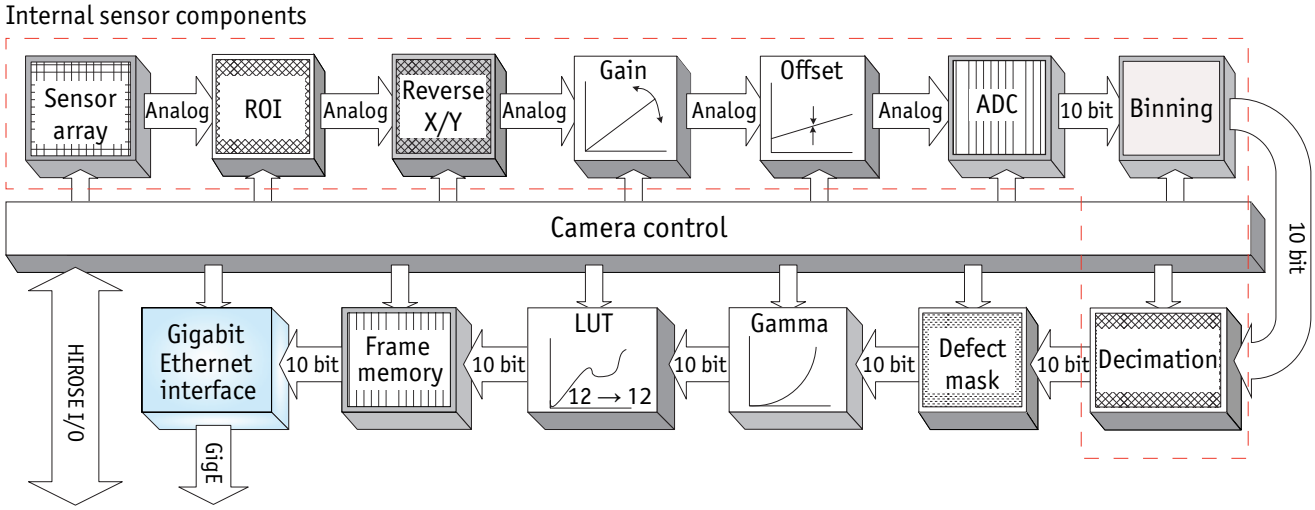



Figure 44: Block diagram of Mako G-131 and Mako G-192 monochrome cameras

### Mako G-223B, Mako G-223 NIR, Mako G-419B, Mako G-419 NIR

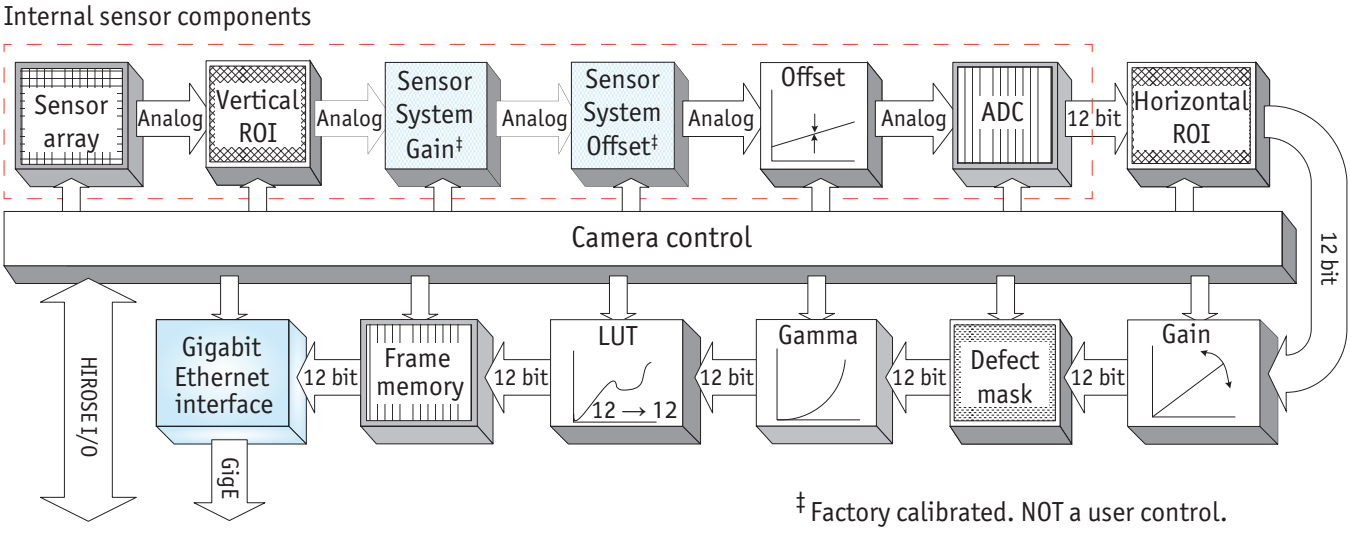
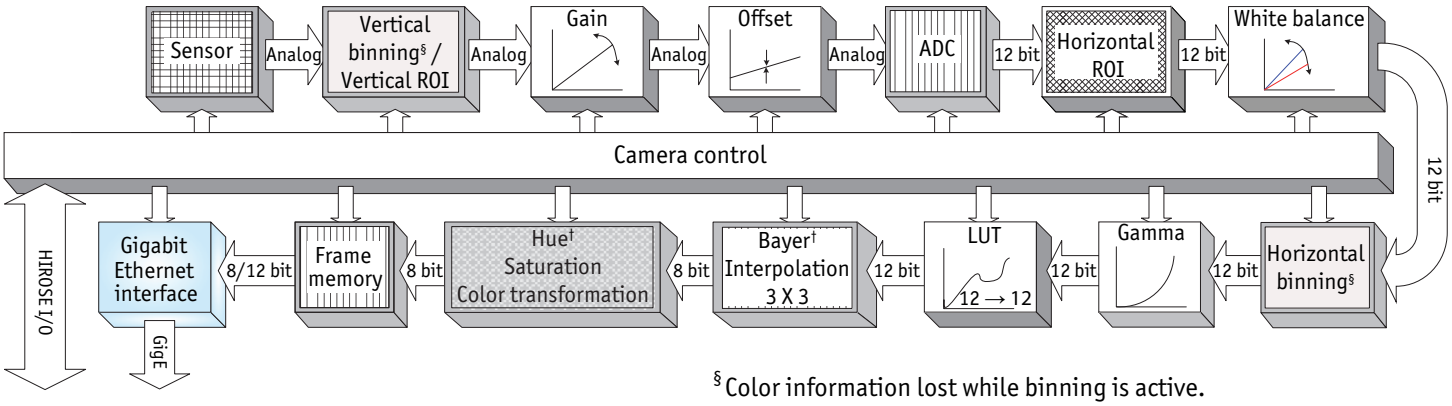



Figure 45: Block diagram of Mako G-223, Mako G-223 NIR, Mako G-419, and Mako G-419 NIR monochrome cameras

# Mako color cameras

## Mako with CCD sensors

### Mako G-032C, Mako G-050C, Mako G-095C, Mako G-125C



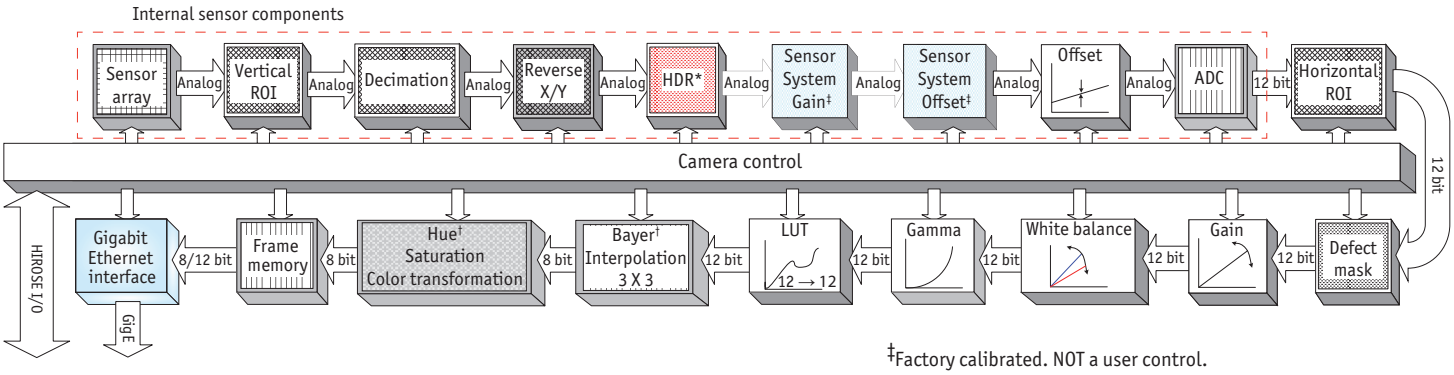

§ Color information lost while binning is active.

† For on-camera interpolated *PixelFormats* only—outputs 8 bit. Raw un-interpolated *PixelFormats* skip this block—outputs 8/12 bit depending upon the bit depth of *PixelFormat* used.

Figure 46: Block diagram of Mako color cameras with CCD sensors

## Mako with CMOS sensors

### Mako G-030C

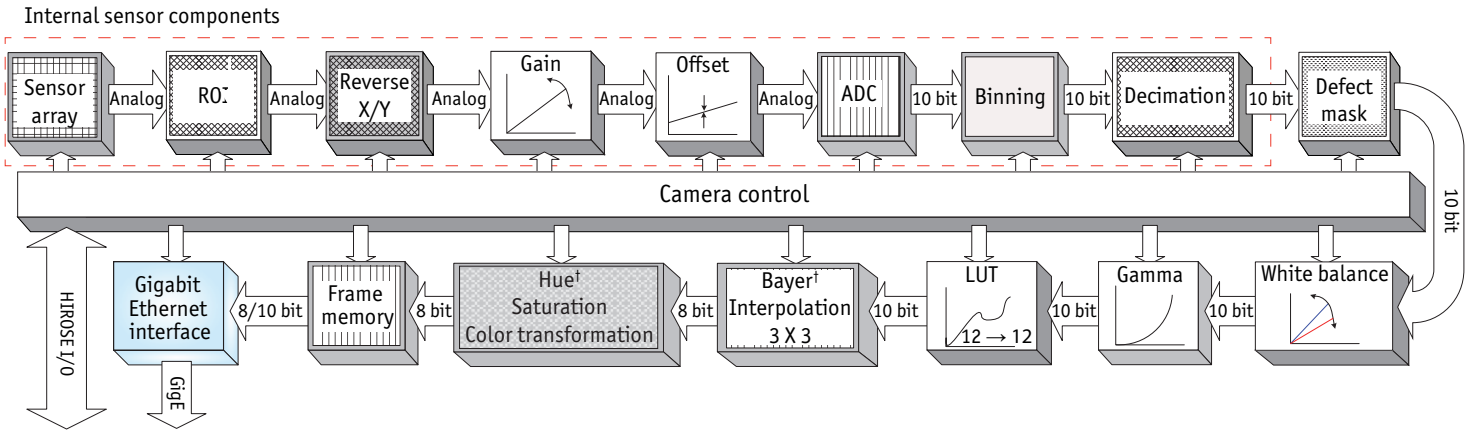



‡ Factory calibrated. NOT a user control.

† For on-camera interpolated *PixelFormats* only—outputs 8 bit. Raw un-interpolated *PixelFormats* skip this block—outputs 8/12 bit depending upon the bit depth of *PixelFormat* used.

Figure 47: Block diagram of Mako G-030C color cameras

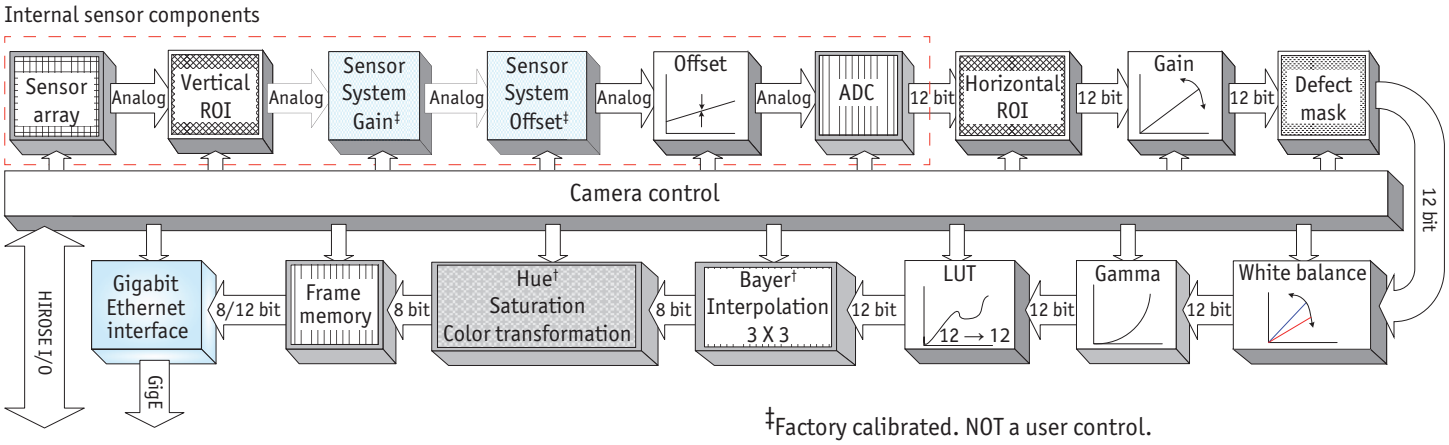
## Mako G-131C, Mako G-192C




†For on-camera interpolated *PixelFormats* only—outputs 8 bit. Raw un-interpolated *PixelFormats* skip this block—outputs 8/10 bit depending upon the bit depth of *PixelFormat* used.

Figure 48: Block diagram of Mako G-131 and Mako G-192 color cameras

## Mako G-223C, Mako G-419C




‡Factory calibrated. NOT a user control.

†For on-camera interpolated *PixelFormats* only—outputs 8 bit. Raw un-interpolated *PixelFormats* skip this block—outputs 8/12 bit depending upon the bit depth of *PixelFormat* used.

Figure 49: Block diagram of Mako G-223 and Mako G-419 color cameras

# Camera features

This chapter lists the camera and driver features for Mako cameras as displayed with the Vimba Viewer.

**www**

For a detailed description of all GigE camera and driver controls, refer to the **GigE Camera and Driver Features** document:

http://www.alliedvisiontec.com/fileadmin/content/PDF/Software/Prosilica_software/Prosilica_firmware/AVT_GigE_Camera_and_Driver_Features.pdf

| Hierarchy level 1 | Hierarchy level 2 | Hierarchy level 3 | Hierarchy level 4 |
|---|---|---|---|
| **Acquisition** | | | |
| | AcquisitionAbort | | |
| | AcquisitionFrameCount | | |
| | AcquisitionFrameRateAbs | | |
| | AcquisitionFrameRateLimit | | |
| | AcquisitionMode | | |
| | | Continous | |
| | | SingleFrame | |
| | | MultiFrame | |
| | | Recorder | |
| | AcquisitionStart | | |
| | AcquisitionStop | | |
| | RecorderPreEventCount | | |
| | SensorShutterMode (available only on G-131 and G-192) | | |
| | | Global | |
| | | Rolling | |
| | | GlobalReset | |
| | Trigger | | |
| | | TriggerActivation | |
| | | | RisingEdge |
| | | | FallingEdge |
| | | | AnyEdge |
| | | | LevelHigh |
| | | | LevelLow |
| | | TriggerDelayAbs | |
| | | TriggerMode | |
| | | | On |
| | | | Off |
| | | TriggerOverlap | |

Table 28: Available Mako camera and driver features

| Hierarchy level 1 | Hierarchy level 2 | Hierarchy level 3 | Hierarchy level 4 |
|---|---|---|---|
| | | | Off |
| | | | PreviousFrame |
| | | TriggerSelector | |
| | | | FrameStart |
| | | | AcquisitionStart |
| | | | AcquisitionEnd |
| | | | AcquisitionRecord |
| | | TriggerSoftware | |
| | | TriggerSource | |
| | | | Freerun |
| | | | Line1 |
| | | | FixedRate |
| | | | Software |
| **BufferHandlingControl** (Vimba v1.3 or higher) | | | |
| | StreamAnnounceBufferMinimum | | |
| | StreamAnnouncedBufferCount | | |
| | StreamBufferHandlingMode | | |
| **Controls** | | | |
| | BlackLevelControl | | |
| | | BlackLevel | |
| | | BlackLevelSelector | |
| | | | All |
| | ColorTransformationControl | | |
| | | ColorTransformationMode | |
| | | | Off |
| | | | Manual |
| | | ColorTransformationSelector | |
| | | | RBGtoRGB |
| | | ColorTransformationValue | |
| | | ColorTransformationValueSelector | |
| | DSPSubregion | | |
| | | DSPSubregionBottom | |
| | | DSPSubregionLeft | |
| | | DSPSubregionRight | |
| | | DSPSubregionTop | |
| | DefectMaskEnable (available on all models except G-032, G-050, G-095, and G-125) | | |
| | Exposure | | |
| | | ExposureAuto | |
| | | | Off |
| | | | Once |

Table 28: Available Mako camera and driver features

| Hierarchy level 1 | Hierarchy level 2 | Hierarchy level 3 | Hierarchy level 4 |
|---|---|---|---|
| | | | Continuous |
| | | ExposureAutoControl | |
| | | | ExposureAutoAdjustTol |
| | | | ExposureAutoAlg |
| | | | ExposureAutoMax |
| | | | ExposureAutoMin |
| | | | ExposureAutoOutliers |
| | | | ExposureAutoRate |
| | | | ExposureAutoTarget |
| | | ExposureMode | |
| | | | Timed |
| | | | TriggerWidth |
| | | | PieceWiseLinearHDR (available only on G-030) |
| | | ExposureTimeAbs | |
| | | ExposureTimeIncrement | |
| | | ExposureTimePWL1 (available only on G-030) | |
| | | ExposureTimePWL2 (available only on G-030) | |
| | | ThresholdPWL1 (available only on G-030) | |
| | | ThresholdPWL2 (available only on G-030) | |
| | GainControl | | |
| | | Gain | |
| | | GainAuto | |
| | | | Off |
| | | | Once |
| | | | Continuous |
| | | GainAutoControl | |
| | | | GainAutoAdjustTol |
| | | | GainAutoMax |
| | | | GainAutoMin |
| | | | GainAutoOutliers |
| | | | GainAutoRate |
| | | | GainAutoTarget |
| | | GainSelector | |
| | Gamma | | |
| | Hue | | |
| | LUTControl | | |
| | | LUTEnable | |
| | | LUTIndex | |
| | | LUTInfo | |
| | | | LUTAddress |
| | | | LUTBitLengthIn |
| | | | LUTBitLengthOut |
| | | | LUTSize |

Table 28: Available Mako camera and driver features

| Hierarchy level 1 | Hierarchy level 2 | Hierarchy level 3 | Hierarchy level 4 |
|---|---|---|---|
| | | LUTLoadAll | |
| | | LUTMode | |
| | | | Luminance |
| | | | Red |
| | | | Green |
| | | | Blue |
| | | LUTSaveAll | |
| | | LUTSelector | |
| | | | LUT1 |
| | | LUTValue | |
| | Saturation | | |
| | Whitebalance | | |
| | | BalanceRatioAbs | |
| | | BalanceRatioSelector | |
| | | | Red |
| | | | Blue |
| | | BalanceWhiteAuto | |
| | | | Off |
| | | | Once |
| | | | Continuous |
| | | BalanceWhiteAutoControl | |
| | | | BalanceWhiteAutoAdjustTol |
| | | | BalanceWhiteAutoRate |
| **DeviceStatus** | | | |
| | DeviceTemperature | | |
| | DeviceTemperatureSelector | | |
| **EventControl** | | | |
| | EventData | | |
| | | EventAcquisitionEndFrameID | |
| | | EventAcquisitionEndTimestamp | |
| | | EventAcquisitionRecordTriggerFrameID | |
| | | EventAcquisitionRecordTriggerTimestamp | |
| | | EventAcquisitionStartFrameID | |
| | | EventAcquisitionStartTimestamp | |
| | | EventErrorFrameID | |
| | | EventErrorTimestamp | |
| | | EvenExposureEndFrameID | |
| | | EventExposureEndTimestamp | |
| | | EventFrameTriggerFrameID | |
| | | EventFrameTriggerReadyFrameID | |
| | | EventFrameTriggerReadyTimestamp | |
| | | EventLine1FallingEdgeFrameID | |
| | | EventLineFallingEdgeTimestamp | |

Table 28: Available Mako camera and driver features

| Hierarchy level 1 | Hierarchy level 2 | Hierarchy level 3 | Hierarchy level 4 |
|---|---|---|---|
| | | EventLineRisingEdgeFrameID | |
| | | EventLineRisingEdgeTimestamp | |
| | | EventOverflowFrameID | |
| | | EventOverflowTimestamp | |
| | EventID | | |
| | | EventAcquisitionEnd | |
| | | EventAcquisitionRecordTrigger | |
| | | EventAcquisitionStart | |
| | | EventError | |
| | | EventExposureEnd | |
| | | EventFrameTrigger | |
| | | EventFrameTriggerReady | |
| | | EventLine1FallingEdge | |
| | | EventLine1RisingEdge | |
| | | EventLine2FallingEdge | |
| | | EventLine2RisingEdge | |
| | | EventLine3FallingEdge | |
| | | EventLine3RisingEdge | |
| | | EventLine4FallingEdge | |
| | | EventLine4RisingEdge | |
| | | EventOverflow | |
| | EventNotification | | |
| | EventSelector | | |
| | EventsEnable1 | | |
| **GigE** | | | |
| | BandwidthCtrlMode | | |
| | ChunkModeActive | | |
| | Configuration | | |
| | | IP Configuration Mode | |
| | Current | | |
| | | Current Default Gateway | |
| | | Current IP Address | |
| | | Current Subnet Mask | |
| | GVCP | | |
| | | Command Retries | |
| | | Command Timeout | |
| | | Heartbeat Interval | |
| | | Heartbeat Timeout<br>(Vimba 1.3 and higher) | |
| | GevSCPSPacketSize | | |
| | NonImagePayloadSize | | |
| | PayloadSize | | |
| | Persistent | | |

Table 28: Available Mako camera and driver features

| Hierarchy level 1 | Hierarchy level 2 | Hierarchy level 3 | Hierarchy level 4 |
|---|---|---|---|
| | | Persistent Default Gateway | |
| | | Persistent IP Address | |
| | | Persistent Subnet Mask | |
| | StreamBytesPerSecond | | |
| | StreamFrameRateConstrain | | |
| | StreamHold | | |
| | | StreamHoldCapacity | |
| | | StreamHoldEnable | |
| | | | Off |
| | | | On |
| | Timestamp | | |
| | | GevTimestampControlLatch | |
| | | GevTimestampControlReset | |
| | | GevTimestampTickFrequency | |
| | | GevTimestampValue | |
| **IO** | | | |
| | Strobe | | |
| | | StrobeDelay | |
| | | StrobeDuration | |
| | | StrobeDurationMode | |
| | | | Source |
| | | | Controlled |
| | | StrobeSource | |
| | | | AcquisitionTriggerReady |
| | | | FrameTriggerReady |
| | | | FrameTrigger |
| | | | Exposung |
| | | | FrameReadout |
| | | | Acquiring |
| | | | LineIn1 |
| | SyncIn | | |
| | | SyncInGlitchFilter | |
| | | SyncInLevels | |
| | | SyncInSelector | |
| | | | SyncIn1 |
| | SyncOut | | |
| | | SyncOutLevels | |
| | | SyncOutPolarity | |
| | | | Normal |
| | | | Invert |
| | | SyncOutSelector | |
| | | | SyncOut1 |
| | | | SyncOut2 |

Table 28: Available Mako camera and driver features

| Hierarchy level 1 | Hierarchy level 2 | Hierarchy level 3 | Hierarchy level 4 |
|---|---|---|---|
| | | | SyncOut3 |
| | | SyncOutSource | |
| | | | GPO |
| | | | AcquisitionTriggerReady |
| | | | FrameTriggerReady |
| | | | Exposing |
| | | | FrameReadout |
| | | | Imaging |
| | | | Acquiring |
| | | | LineIn1 |
| | | | Strobe1 |
| **ImageFormat** | | | |
| | Height | | |
| | HeightMax | | |
| | ImageSize | | |
| | OffsetX | | |
| | OffsetY | | |
| | PixelFormat | | |
| | Width | | |
| | WidthMax | | |
| **ImageMode** | | | |
| | BinningHorizontal | | |
| | BinningHorizontalMode | | |
| | | Sum | |
| | | Average | |
| | BinningVertical | | |
| | BinningVerticalMode | | |
| | | Sum | |
| | | Average | |
| | DecimationHorizontal | | |
| | DecimationVertical | | |
| | ReverseX | | |
| | ReverseY | | |
| | SensorHeight | | |
| | SensorWidth | | |
| **Info** | | | |
| | Device MAC address | | |
| | DeviceFirmwareVersion | | |
| | DeviceID | | |
| | DeviceModelName | | |
| | DevicePartNumber | | |

Table 28: Available Mako camera and driver features

| Hierarchy level 1 | Hierarchy level 2 | Hierarchy level 3 | Hierarchy level 4 |
|---|---|---|---|
| | DeviceScanType | | |
| | DeviceVendorName | | |
| | FirmwareVerBuild | | |
| | FirmwareVerMajor | | |
| | FirmwareVerMinor | | |
| | SensorBits | | |
| | SensorType | | |
| **SavedUserSets** | | | |
| | UserSetDefaultSelector | | |
| | | Default | |
| | | UserSet1 | |
| | | UserSet2 | |
| | | UserSet3 | |
| | UserSetLoad | | |
| | UserSetSave | | |
| | UserSetSelector | | |
| | | Default | |
| | | UserSet1 | |
| | | UserSet2 | |
| | | UserSet3 | |
| **Stream** | | | |
| | Info | | |
| | | GSVP Filter Version | |
| | Multicast | | |
| | | MulticastEnable | |
| | | Multicast IP Address | |
| | Settings | | |
| | | GSVP Adjust Packet Size | |
| | | GSVP Burst Size | |
| | | GSVP Driver Selector | |
| | | GSVP Host Receive Buffers | |
| | | GSVP Max Look Back | |
| | | GSVP Max Requests | |
| | | GSVP Max Wait Size | |
| | | GSVP Missing Size | |
| | | GSVP Packet Size | |
| | | GSVP Tilting Size | |
| | | GSVP Timeout | |
| | Statistics | | |
| | | Stat Frame Rate | |
| | | Stat Frames Delivered | |
| | | Stat Frames Dropped | |

Table 28: Available Mako camera and driver features

| Hierarchy level 1 | Hierarchy level 2 | Hierarchy level 3 | Hierarchy level 4 |
|---|---|---|---|
| | | Stat Frames Rescued | |
| | | Stat Frames Shoved | |
| | | Stat Frames Underrun | |
| | | Stat Local Rate | |
| | | Stat Packets Errors | |
| | | Stat Packets Missed | |
| | | Stat Packets Received | |
| | | Stat Packets Requested | |
| | | Stat Packets Resent | |
| | | Stat Time Elapsed | |
| **StreamInformation** (Vimba v1.3 or higher) | | | |
| | StreamID | | |
| | StreamType | | |

Table 28: Available Mako camera and driver features

# Frame memory

An image is normally captured and transported in consecutive steps. The image is taken, read out from the sensor, digitized and sent over the Gigabit Ethernet network. Mako cameras are equipped with a RAM. Table 29 shows how many frames can be stored by each model.

**Note**

The number of frames (StreamHoldCapacity) depends on resolution, pixel format, and packet size. Stated number of frames is typical for full resolution, Mono8/Bayer8, and GevSCPSPacketSize = 8192.

The memory operates according to the FIFO (first in, first out) principle. This makes addressing for individual images unnecessary.

| Model | Memory size | Pixel format / Resolution / Packet size |
|---|---|---|
| Mako G-030B/C | 64 MB memory: 99 frames | Mono8/Bayer8<br>Full resolution<br>Payload size of 8192 bytes per packet |
| Mako G-032B/C | 64 MB memory: 202 frames | |
| Mako G-050B/C | 64 MB memory: 130 frames | |
| Mako G-095B/C | 64 MB memory: 69 frames | |
| Mako G-125B/C | 64 MB memory: 52 frames | |
| Mako G-131B/C | 64 MB memory: 50 frames | |
| Mako G-192B/C | 64 MB memory: 34 frames | |
| Mako G-223B/C | 64 MB memory: 29 frames | |
| Mako G-419B/C | 64 MB memory: 15 frames | |

Table 29: Image memory size

# Resolution and ROI frame rates

This section charts the resulting frame rate from changing sensor height from full image to a single line. Unless otherwise noted, sensors do not give an increase in readout speed with a reduction in width.

**Note**

- Data was generated using **StreamBytesPerSecond = 124 MB/s** (full bandwidth) and an 8-bit pixel format. Frame rates may be lower if using network hardware incapable of 124 MB/s.
- **ROIs** are taken as **center image** for maximum speed advantage, where feature **OffsetY = (full sensor height – ROI height)/2**.
- **BinningVertical** is horizontal row summing on CCD before readout. The frame rate for an ROI at the same effective height as binning will be slower because the CCD still needs to read out the “fast readout rows” in ROI mode.

# Mako G-030B/C: ROI frame rates

$$\text{Max. frame rate} = \frac{1}{204\ \mu s + 6.25\ \mu s \times \text{ROI height}}$$

Formula 1: **Mako G-030**: theoretical maximum frame rate of CCD

Maximum frame rate at full resolution according to formula: 309 fps

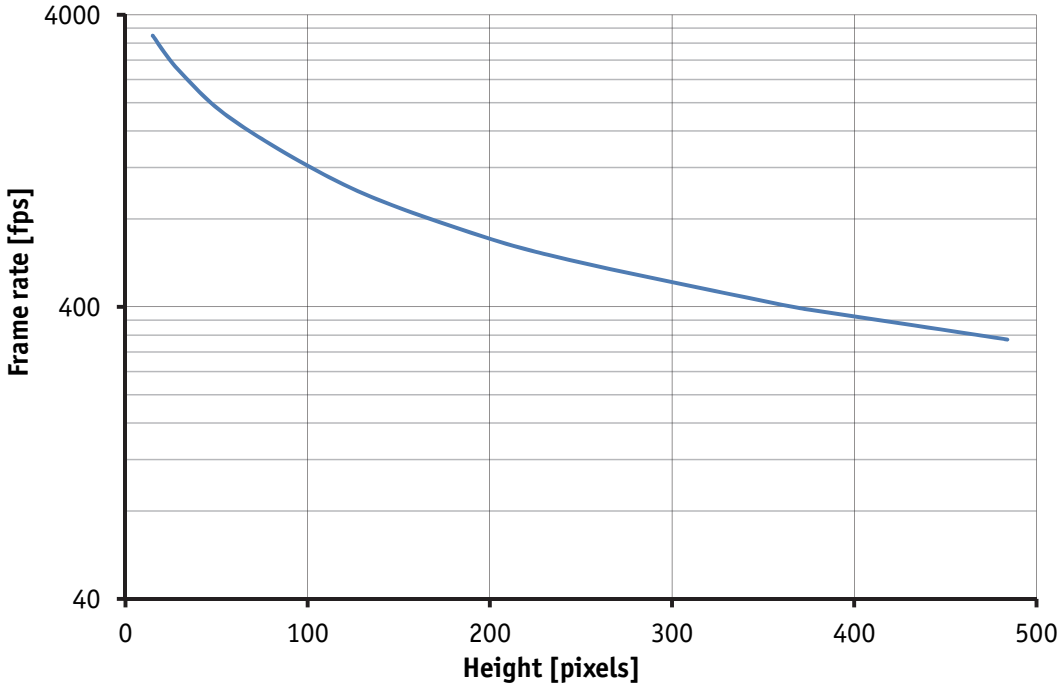



Figure 50: Frame rates **Mako G-030** as function of ROI height [**width=644**]

| ROI height | Width* | Frame rate |
|---|---|---|
| 484 | 644 | 309 |
| 480 | 644 | 312 |
| 384 | 644 | 384 |
| 360 | 644 | 407 |
| 240 | 644 | 586 |
| 180 | 644 | 752 |
| 120 | 644 | 1048 |
| 60 | 644 | 1727 |
| 30 | 644 | 2554 |
| 15 | 644 | 3393 |

Table 30: Frame rates (fps) of **Mako G-030** as function of ROI height (pixel) [**width=644**]

*There will be an increase in frame rate with reduced width if the camera is bandwidth limited.

# Mako G-032B/C: ROI frame rates

$$\text{Max. frame rate of CCD} = \frac{1}{19.46\ \mu s \times \text{ROI height} + 2.29\ \mu s \times (492 - \text{ROI height}) + 195.81\ \mu s}$$

Formula 2: **Mako G-032**: theoretical maximum frame rate of CCD

Maximum frame rate at full resolution according to formula: 102.3 fps

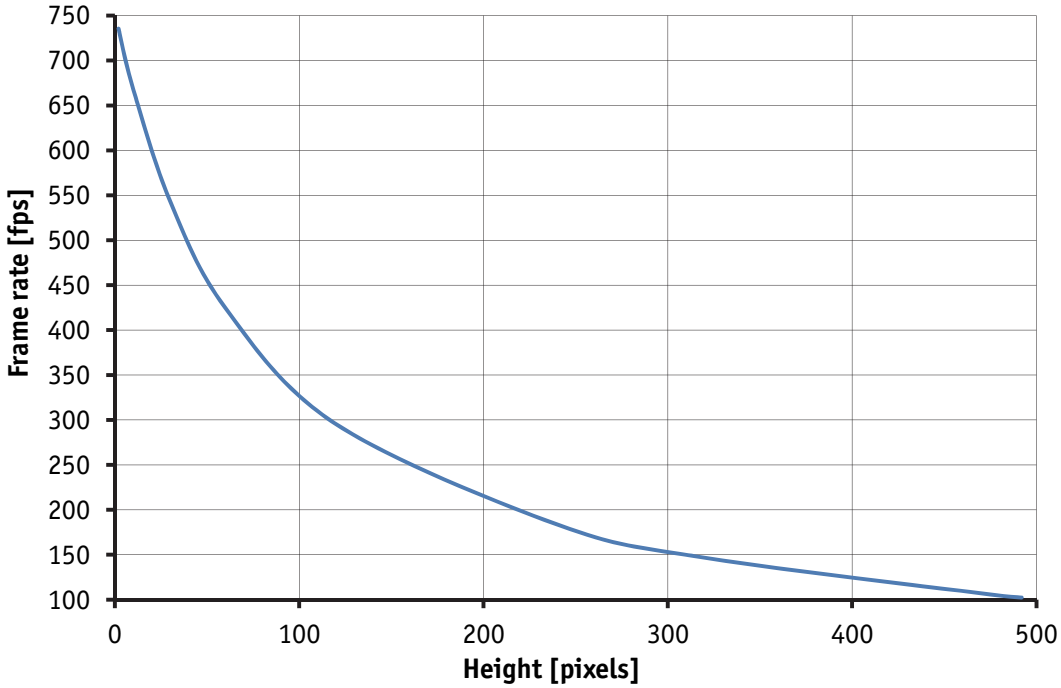



Figure 51: Frame rates **Mako G-032** as function of ROI height [**width=658**]

| ROI height | Frame rate* |
|---|---|
| 492 | 102.3 |
| 480 | 104.5 |
| 320 | 146.6 |
| 240 | 183.5 |
| 120 | 295.3 |
| 60 | 424.5 |
| 30 | 543.3 |
| 10 | 667.9 |
| 2 | 735.4 |

Table 31: Frame rates (fps) of **Mako G-032** as function of ROI height (pixel) [**width=658**]

* CCD = theoretical maximum frame rate (in fps) of CCD according to given formula

# Mako G-050B/C: ROI frame rates

$$\text{Max. frame rate of CCD} = \frac{1}{22.53\ \mu s \times \text{ROI height} + 5.32\ \mu s \times (614 - \text{ROI height}) + 193.63\ \mu s}$$

Formula 3: **Mako G-050**: theoretical maximum frame rate of CCD

Maximum frame rate at full resolution according to formula: 71.2 fps

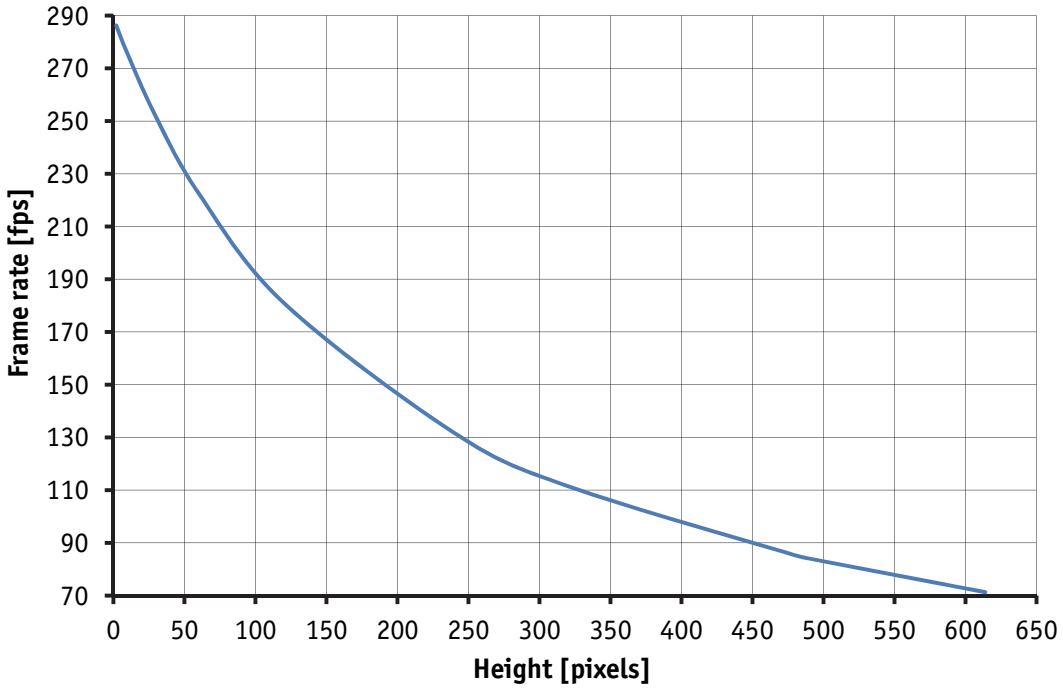



Figure 52: Frame rates **Mako G-050** as function of ROI height [**width=812**]

| ROI height | Frame rate* |
|---|---|
| 614 | 71.2 |
| 492 | 83.8 |
| 480 | 85.3 |
| 320 | 111.5 |
| 240 | 131.7 |
| 120 | 181.0 |
| 60 | 222.6 |
| 30 | 251.5 |
| 10 | 275.4 |
| 2 | 286.2 |

Table 32: Frame rates (fps) of **Mako G-050** as function of ROI height (pixel) [**width=812**]

* CCD = theoretical maximum frame rate (in fps) of CCD according to given formula

# Mako G-095B/C: ROI frame rates

$$\text{Max. frame rate of CCD} = \frac{1}{31.54\ \mu s \times \text{ROI height} + 4.87\ \mu s \times (734 - \text{ROI height}) + 219.97\ \mu s}$$

Formula 4: **Mako G-095**: theoretical maximum frame rate of CCD

Maximum frame rate at full resolution according to formula: 42.8 fps

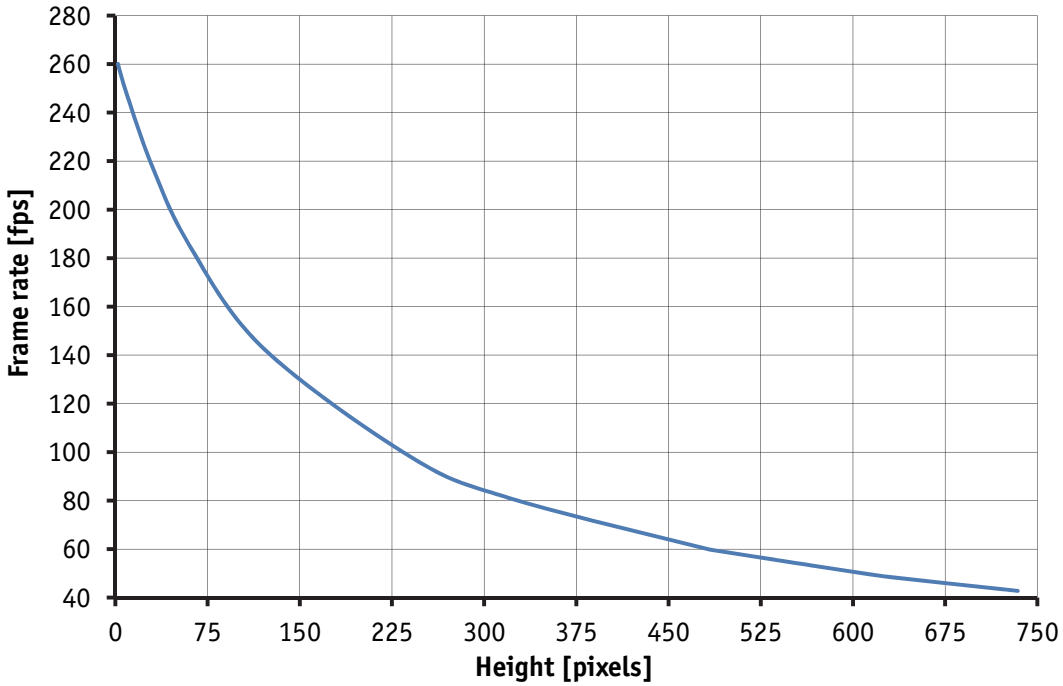



Figure 53: Frame rates **Mako G-095** as function of ROI height [**width=1292**]

| ROI height | Frame rate* |
|---|---|
| 734 | 42.8 |
| 640 | 47.9 |
| 614 | 49.5 |
| 492 | 59.1 |
| 480 | 60.2 |
| 320 | 81.1 |
| 240 | 98.1 |
| 120 | 143.0 |
| 60 | 185.4 |
| 30 | 217.8 |
| 10 | 246.4 |
| 2 | 260.1 |

Table 33: Frame rates (fps) of **Mako G-095** as function of ROI height (pixel) [**width=1292**]

* CCD = theoretical maximum frame rate (in fps) of CCD according to given formula

# Mako G-125B/C: ROI frame rates

$$\text{Max. frame rate of CCD} = \frac{1}{34.01\ \mu s \times \text{ROI height} + 3.09\ \mu s \times (964 - \text{ROI height}) + 176.42\ \mu s}$$

Formula 5: **Mako G-125**: theoretical maximum frame rate of CCD

Maximum frame rate at full resolution according to formula: 30.3 fps

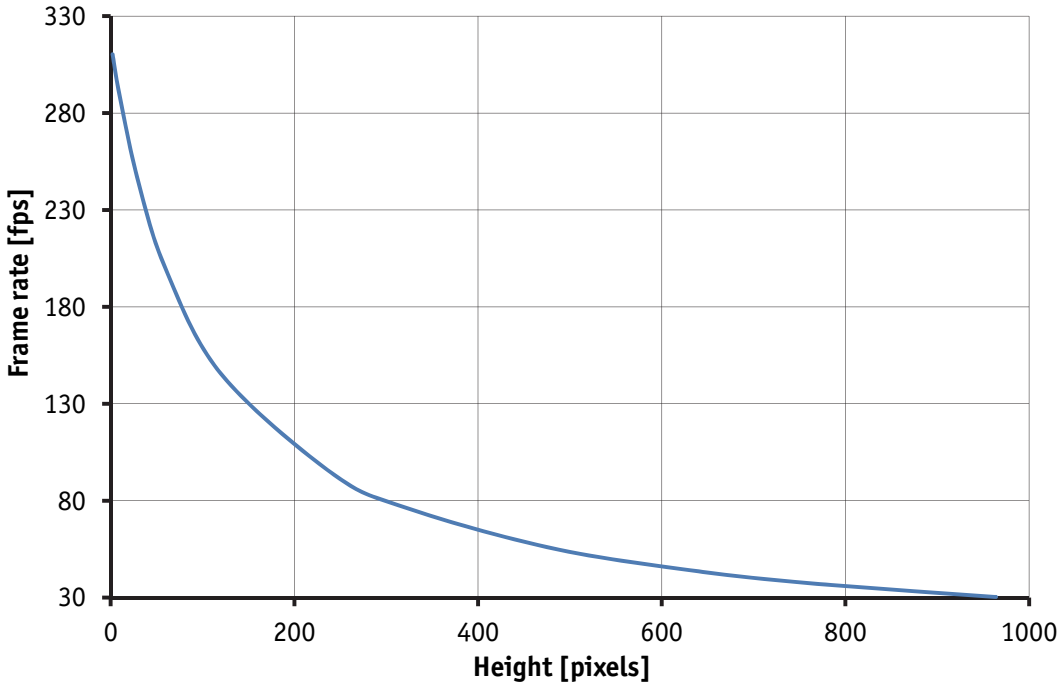



Figure 54: Frame rates **Mako G-125** as function of ROI height [**width=1292**]

| ROI height | Frame rate* |
|---|---|
| 964 | 30.3 |
| 960 | 30.4 |
| 768 | 37.1 |
| 640 | 43.5 |
| 480 | 55.5 |
| 320 | 76.5 |
| 240 | 94.4 |
| 120 | 145.5 |
| 60 | 199.3 |
| 30 | 244.5 |
| 10 | 288.1 |
| 2 | 310.3 |

Table 34: Frame rates (fps) of **Mako G-125** as function of ROI height (pixel) [**width=1292**]

* CCD = theoretical maximum frame rate (in fps) of CCD according to given formula

# Mako G-131B/C: ROI frame rates

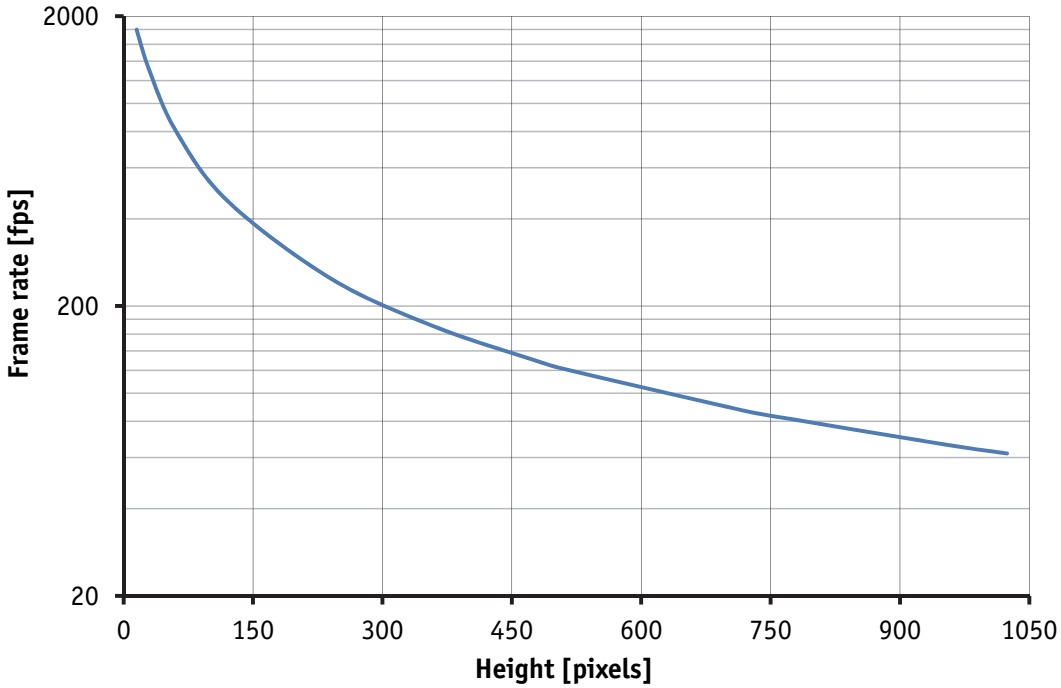



Figure 55: Frame rates **Mako G-131** as function of ROI height [**width=1280**]

| ROI height | Width* | Frame rate |
|---|---|---|
| 1024 | 1280 | 62 |
| 960 | 1280 | 66 |
| 768 | 1280 | 82 |
| 720 | 1280 | 87 |
| 512 | 1280 | 121 |
| 480 | 1280 | 129 |
| 360 | 1280 | 170 |
| 240 | 1280 | 249 |
| 120 | 1280 | 462 |
| 60 | 1280 | 809 |
| 30 | 1280 | 1295 |
| 15 | 1280 | 1798 |

Table 35: Frame rates (fps) of **Mako G-131** as function of ROI height (pixel) [**width=1280**]

*There will be an increase in frame rate with reduced width for color camera if it is bandwidth limited.

# Mako G-192B/C: ROI frame rates

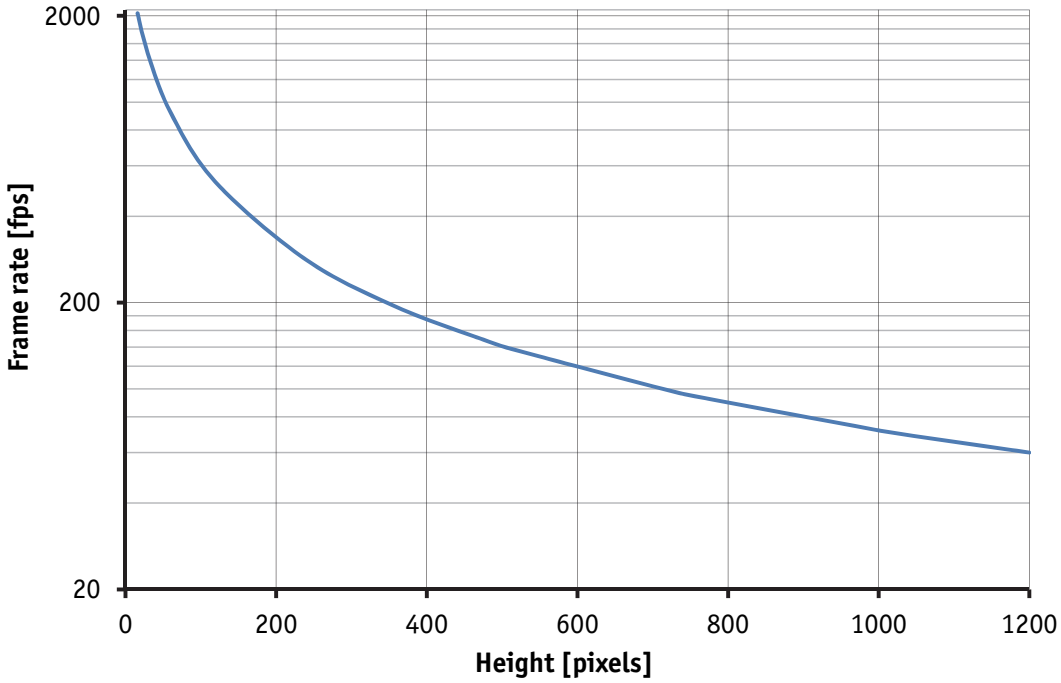



Figure 56: Frame rates **Mako G-192** as function of ROI height [**width=1600**]

| ROI height | Width* | Frame rate |
|---|---|---|
| 1200 | 1600 | 60 |
| 1024 | 1600 | 70 |
| 960 | 1600 | 75 |
| 768 | 1600 | 93 |
| 720 | 1600 | 99 |
| 512 | 1600 | 138 |
| 480 | 1600 | 147 |
| 360 | 1600 | 193 |
| 240 | 1600 | 282 |
| 120 | 1600 | 525 |
| 60 | 1600 | 919 |
| 30 | 1600 | 1470 |
| 16 | 1600 | 2042 |

Table 36: Frame rates (fps) of **Mako G-192** as function of ROI height (pixel) [**width=1600**]

*There will be an increase in frame rate with reduced width if the camera is bandwidth limited.

# Mako G-223B/C: ROI frame rates

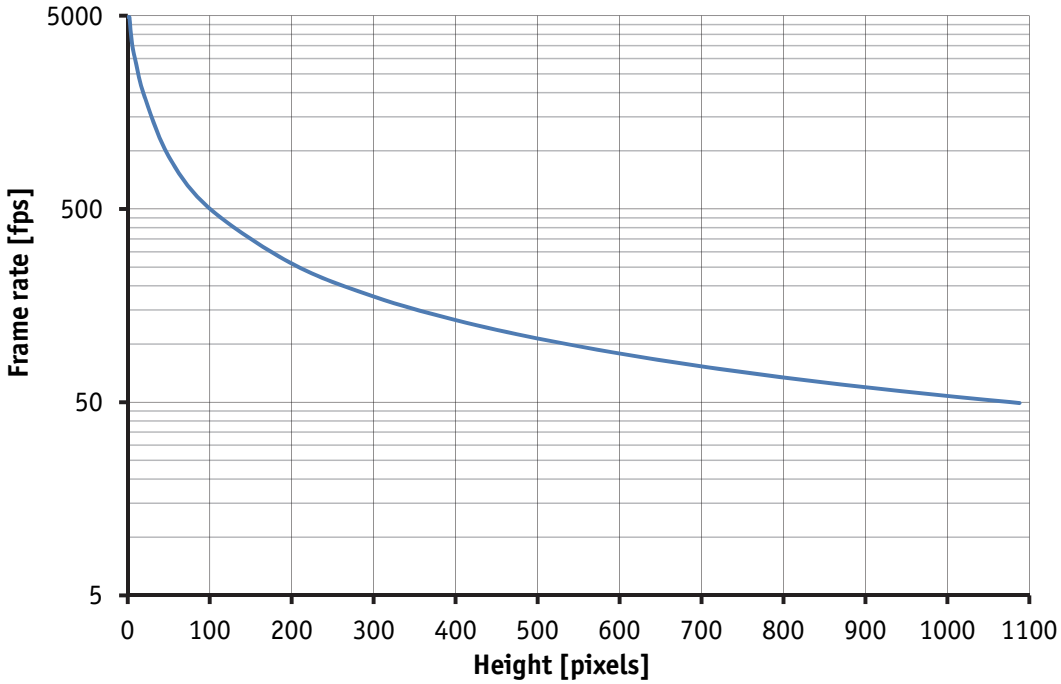



Figure 57: Frame rates **Mako G-223** as function of ROI height

| ROI height | Width* | Frame rate |
|---|---|---|
| 1088 | 2048 | 49.5 |
| 1000 | 2048 | 53.8 |
| 900 | 2048 | 59.7 |
| 800 | 2048 | 67.1 |
| 700 | 2048 | 76.6 |
| 600 | 2048 | 89.2 |
| 500 | 2048 | 106.8 |
| 400 | 2048 | 132.9 |
| 300 | 2048 | 176.1 |
| 200 | 2048 | 260.8 |
| 100 | 2048 | 502.1 |
| 50 | 2048 | 934.6 |
| 20 | 2048 | 1933.8 |
| 10 | 2048 | 2847.3 |
| 5 | 2048 | 3624.5 |
| 2 | 2048 | 4906.7 |
| 1 | 2048 | 4926.1 |

Table 37: Frame rates (fps) of **Mako G-223** as function of ROI height (pixel)

*There will be an increase in frame rate with reduced width if the camera is bandwidth limited.

# Mako G-419B/C: ROI frame rates

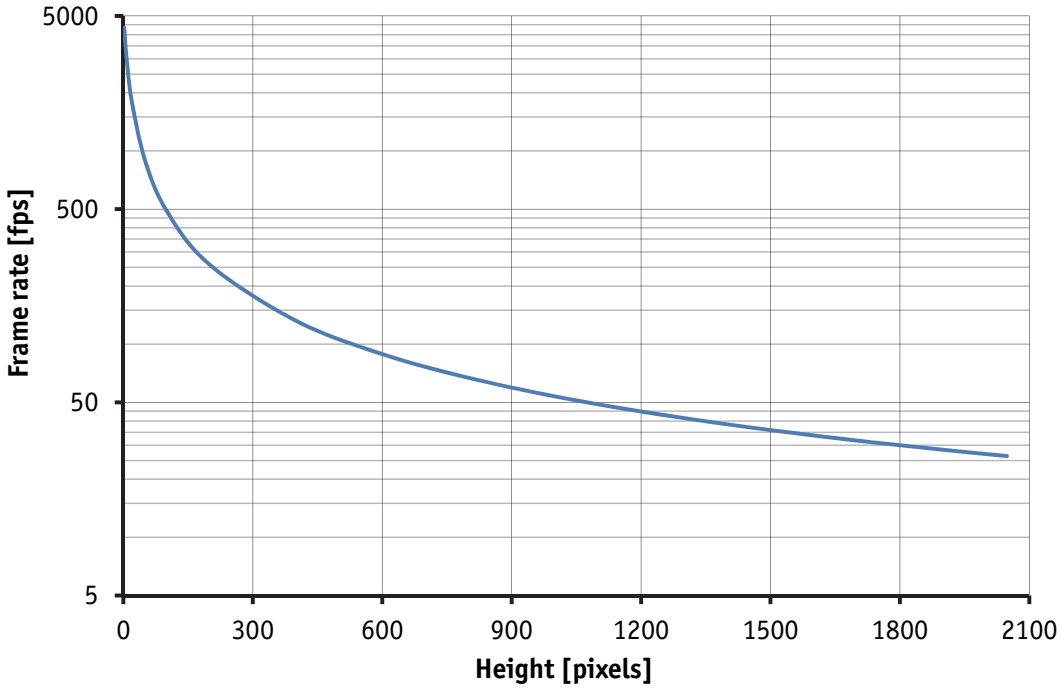



Figure 58: Frame rates **Mako G-419** as function of ROI height

| ROI height | Width* | Frame rate |
|---|---|---|
| 2048 | 2048 | 26.3 |
| 2000 | 2048 | 26.9 |
| 1800 | 2048 | 29.9 |
| 1600 | 2048 | 33.6 |
| 1400 | 2048 | 38.4 |
| 1200 | 2048 | 44.8 |
| 1000 | 2048 | 53.7 |
| 800 | 2048 | 66.9 |
| 600 | 2048 | 88.8 |
| 400 | 2048 | 132.1 |
| 200 | 2048 | 257.7 |
| 100 | 2048 | 490.8 |
| 50 | 2048 | 895.9 |
| 20 | 2048 | 1775.5 |
| 10 | 2048 | 2639.2 |
| 5 | 2048 | 3486.7 |
| 2 | 2048 | 4342.1 |

Table 38: Frame rates (fps) of **Mako G-419** as function of ROI height (pixel)

*There will be an increase in frame rate with reduced width if the camera is bandwidth limited.

# Appendix

## Sensor position accuracy of Mako cameras

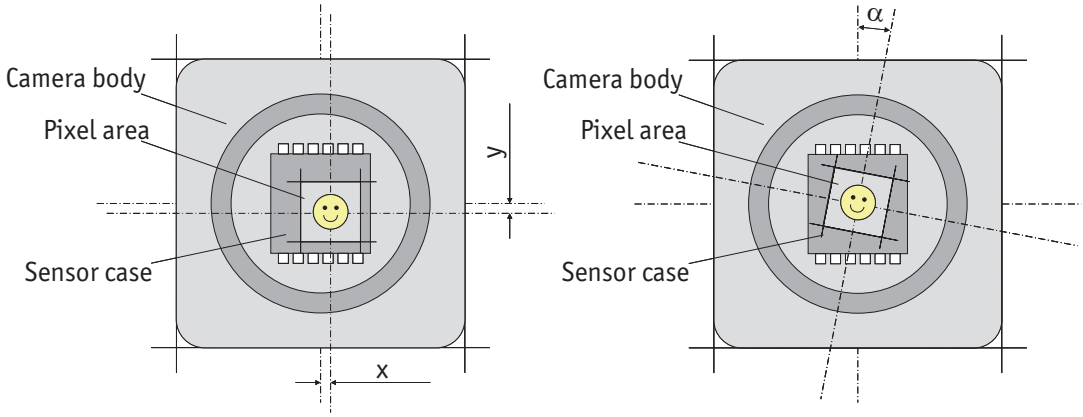



Figure 59: Allied Vision sensor position accuracy

### Method of positioning

Optical alignment of the photo sensitive sensor area into the camera front module (lens mount front flange).

### Reference points

Sensor: center of the pixel area (photo sensitive cells).
Camera: Center of the camera front flange (outer case edges).

### Accuracy

x/y: ±150 µm (sensor shift)

z: 0 µm to -150 µm (optical back focal length)

α: ±0.5° (sensor rotation)

**Note** x/y - tolerances between the C-Mount hole and the pixel area may be higher.

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